Technical Assistance Consultant’s Report

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Study of Large Dams and Recommended Practices
(Financed by the Japan Special Fund)

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For Asian Development Bank

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<td>ADB</td>
<td>Asian Development Bank</td>
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<tr>
<td>BOD</td>
<td>Biochemical Oxygen Demand</td>
</tr>
<tr>
<td>CEB</td>
<td>Ceylon Electricity Board</td>
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<tr>
<td>DO</td>
<td>Dissolved Oxygen</td>
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<td>EA</td>
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<td>EdL</td>
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<td>Environmental Impact Assessment</td>
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<td>MRMP</td>
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<td>NAPOCOR</td>
<td>National Power Corporation</td>
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<td>Netherland Development Consultants</td>
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<td>NGO</td>
<td>Non-Government Organization</td>
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<td>NIA</td>
<td>National Irrigation Authority</td>
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<td>Seasonal Operating Plan</td>
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<td>TOR</td>
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<td>USAID</td>
<td>United States Agency for International Development</td>
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<tr>
<td>USBR</td>
<td>United States Bureau of Reclamation</td>
</tr>
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<td>WCD</td>
<td>World Commission on Dams</td>
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<td>WHDC</td>
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EXECUTIVE SUMMARY

ES 1. Introduction to Large Dams and Recommended Practices

ES 1.1 Background

This study was carried out as an Asian Development Bank Regional Technical Assistance project, RETA 5828, and implemented by an International Consultant Team headed by the Southeast Asia Technology Company Limited of Bangkok.

The Asian Development Bank’s (ADB) evaluation study on large dams in Asian developing countries, was carried out as a complementary study to a similar study by the World Commission on Dams (WCD)\(^1\) completed in November 2000. The studies were both undertaken as a result of increasing controversy about large dams. Various non-governmental organisations (NGOs) have severely criticised dams as counterproductive and environmentally destructive. However, proponents of dams have pointed out that dams have made a significant contribution to human development and this view has been accepted by WCD\(^1\).

It must also be noted that deficiencies in the planning/implementation of large dam projects have been recognised by large dam proponents, and the planning process has been, or can be, improved. Further improvements will enable the planning of a large dam project to be both economically and environmentally acceptable. Thus, the purpose of the WCD and ADB studies has been/is:

(a) To evaluate the actual history of several selected large-scale dam projects; in order to provide conclusions as to their economic and environmental effectiveness; and

(b) From the lessons learned from these studies to prepare a set of practicable guidelines by which future planning and implementation of large-scale dams can be made truly technically, economically and environmentally sound.

While the WCD study comprised a large-scale global project, based on detailed evaluation of eight selected case studies, a cross-check study of 125 existing dams and 17 thematic review papers, the present Study is limited only to case studies of four dam projects, preceded by a wide-ranging literature review. However, since they are all Asian projects, the Study focuses

\(^1\) “Dams and Development”, report by the World Commission on Dams, November 2000.
on the Asian region. Its approach, as specified by its Terms of Reference (TOR) required a study approach similar to that used by WCD.

**ES 1.2 Study Components**

The Study was carried out by an international study team drawn from several international consultancy firms, namely, Southeast Asia Technology Co., Ltd., the Asian Institute of Technology Alumni Network (Hong Kong), Lahmeyer International GmbH (Germany), SCHEMA Konsult (the Philippines), plus an Advisory Panel established to guide the team’s efforts.

The study components comprised:

(a) An extensive literature review relating to dams world-wide;

(b) Development of a procedure for selecting projects for the four case studies representing geographical distribution in the region and encompassing different types of dams, with the Study being conducted in two phases comprising (i) a review of literature and (ii) site visits;

(c) Selection of the projects for the four case studies: one project each in the Lao People’s Democratic Republic (Lao PDR) (Nam Ngum 1), the Philippines (Magat), Sri Lanka (Victoria) and the People’s Republic of China (Lingjintan); Table ES1-1 summarises the main characteristics of the four case study projects selected;

(d) Development of the subject findings from the case studies, emphasising the key issues and the lessons learnt from them;

(e) Formulation of recommended guidelines for conducting the studies of proposed large-scale dam projects in Asia in order to ensure: (i) it is justifiable to proceed with a particular project up to final design/construction/operation; and, if so, (ii) incorporation of practical provisions into the planning processes to ensure that the project will be technically, economically and environmentally sound, whilst providing protection of the affected population and the natural environment.

The steps involved in project planning and implementation must make certain that adequate attention is given to the social and environmental parameters. This requirement applies to all types of large dam projects, including multipurpose dams and dams with a primary focus on hydropower, irrigation, flood control, and water supply for urban/industrial development.
ES 2. Case Study Analysis

Table ES 2-1 summarises the major characteristics of the four case study projects. The Study draws together observations on the ways in which the four case study projects developed from the initial idea to construction, and thence to operation. The various discussion issues included:

(a) Project Justification;
(b) Hydropower Planning;
(c) Institutional framework;
(d) Engineering;
(e) Financial and Economic Appraisal;
(f) Social Assessment;
(g) Environmental Assessment (EIA);
(h) Project Implementation;
(i) Project Operation;
(j) Comparative Summary of Project Development Processes for the four case studies.
Table ES 2-1: Characteristics of the Case Study Projects

<table>
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<th>Characteristic</th>
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<th>Victoria</th>
<th>Magat</th>
<th>Lingjintan</th>
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<tr>
<td>a) Watershed</td>
<td></td>
<td></td>
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<tr>
<td>Drainage area (km²)</td>
<td>8,460</td>
<td>1,891</td>
<td>4,143</td>
<td>85,800</td>
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<tr>
<td>Average inflow (10⁶ m³)</td>
<td>9,713</td>
<td>3,321 (1944-74)</td>
<td>6,545 (1953 –85)</td>
<td>65,910 (1953-91)</td>
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<tr>
<td>b) Reservoir</td>
<td></td>
<td></td>
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<td>Full Supply Level (m asl)</td>
<td>212</td>
<td>438.0</td>
<td>193.0</td>
<td>51.0</td>
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<tr>
<td>Minimum Operating Level (m asl)</td>
<td>196</td>
<td>370.0</td>
<td>160.0</td>
<td>49.1</td>
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<td>Reservoir area at FSL (km²)</td>
<td>369.5</td>
<td>23.7</td>
<td>45</td>
<td>26</td>
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<td>Gross Storage at FSL (10⁶ m³)</td>
<td>7,010</td>
<td>722</td>
<td>1,250</td>
<td>634</td>
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<td>Active Storage (10⁶ m³)</td>
<td>4,714</td>
<td>688</td>
<td>932</td>
<td>46</td>
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<td>Annual Sedimentation (10⁶ m³)</td>
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<td>0.49 (bathymetric survey after 9 yrs)</td>
<td>6.6 (FS estimate)</td>
<td>Minimal</td>
</tr>
<tr>
<td>c) Dam</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type</td>
<td>Mass-concrete gravity</td>
<td>Double-curvature concrete arch</td>
<td>Zoned Earth &amp; Rockfill</td>
<td>Concrete gravity</td>
</tr>
<tr>
<td>Maximum height (m)</td>
<td>75</td>
<td>122</td>
<td>114</td>
<td>52</td>
</tr>
<tr>
<td>Crest length (m)</td>
<td>468</td>
<td>520</td>
<td>4,160</td>
<td>915</td>
</tr>
<tr>
<td>d) Spillway</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type</td>
<td>Radial gate chute</td>
<td>Radial gates</td>
<td>Gated open chute with flip bucket</td>
<td>Flood sluice with stilling basin</td>
</tr>
<tr>
<td>Discharge capacity (m³/s)</td>
<td>4,220</td>
<td>7,900</td>
<td>30,600</td>
<td>20,000</td>
</tr>
<tr>
<td>e) Reservoir Outlets</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power Outlet</td>
<td>Fixed at 185 m asl None</td>
<td>Fixed at 360 m asl None</td>
<td>Fixed at 150 m asl Maris, Baligatan and Siffris Dams None</td>
<td>Bulb turbines Not applicable</td>
</tr>
<tr>
<td>Irrigation Outlet</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>Bottom Outlet</td>
<td>None</td>
<td>760 m³/s capacity</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>f) Hydropower Components</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Location of Powerhouse</td>
<td>Surface Francis</td>
<td>Surface Francis</td>
<td>Surface Francis</td>
<td>Surface Bulb</td>
</tr>
<tr>
<td>Turbine Type</td>
<td>38.5</td>
<td>185</td>
<td>81</td>
<td>8.5</td>
</tr>
<tr>
<td>Installed Capacity (MW)</td>
<td>2 * 15 &amp; 3 * 40 (955, 1993-98)</td>
<td>3 * 70 (672, 1985-99)</td>
<td>4 * 90 (1,200, expected)</td>
<td>9 * 30 (963, 1998-99)</td>
</tr>
<tr>
<td>Average Generation (GWh/yr)</td>
<td>Variable None</td>
<td>Variable None</td>
<td>Variable None</td>
<td>Primarily base load None</td>
</tr>
<tr>
<td>Operational duty</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>Transbasin diversion</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g) Irrigation Aspects</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Irrigation benefits delayed because of civil strife/ lack of donor support</td>
<td>Minimal irrigation benefits because of security problems</td>
<td>Substantial irrigation benefits</td>
<td>Not applicable</td>
<td></td>
</tr>
<tr>
<td>h) Environmental Aspects</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-Stratification</td>
<td>-Incremental forest cover improvement</td>
<td>-Decline in watershed forests</td>
<td>-Construction has destroyed some fish spawning area</td>
<td></td>
</tr>
<tr>
<td>-DO level reduction</td>
<td>-Decrease in wildlife biodiversity and population</td>
<td>-Decrease in wildlife biodiversity and population</td>
<td>-Gradual decrease in forest cover</td>
<td></td>
</tr>
<tr>
<td>-Incremental forest cover improvement</td>
<td>-Less abundant fishery resources</td>
<td>-Less abundant fishery resources</td>
<td>-Pollution has affected water quality but it is still within standards</td>
<td></td>
</tr>
<tr>
<td>-Decrease in wildlife biodiversity and population</td>
<td>-Less abundant fishery resources</td>
<td>-Water quality has remained suitable</td>
<td>-Less abundant fishery resources</td>
<td></td>
</tr>
<tr>
<td>-Less abundant fishery resources</td>
<td>-Dewatered reach downstream of dam</td>
<td>-Construction has destroyed some fish spawning area</td>
<td>-Gradual decrease in forest cover</td>
<td></td>
</tr>
<tr>
<td>-Water quality has remained suitable</td>
<td>-Less abundant fishery resources</td>
<td>-Pollution has affected water quality but it is still within standards</td>
<td>-Less abundant fishery resources</td>
<td></td>
</tr>
</tbody>
</table>
Table ES 2-1: Characteristics of the Case Study Projects (Cont’d)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Nam Ngum1</th>
<th>Victoria</th>
<th>Magat</th>
<th>Lingjintan</th>
</tr>
</thead>
<tbody>
<tr>
<td>i) Social Aspects</td>
<td>-Short-lived increase in malaria incidence</td>
<td>-Short-lived increase in malaria incidence</td>
<td>Short-lived increase in malaria incidence</td>
<td>-Short-lived increase in malaria incidence</td>
</tr>
<tr>
<td></td>
<td>-Underestimation of project affected people</td>
<td>-Underestimation of project affected people</td>
<td>-Underestimation of project affected people</td>
<td>-Underestimation of project affected people</td>
</tr>
<tr>
<td></td>
<td>-Considerable livelihood loss</td>
<td>-Considerable livelihood loss</td>
<td>-Considerable livelihood loss</td>
<td>-Considerable livelihood loss</td>
</tr>
</tbody>
</table>

**ES 3. Project Development Effectiveness**

The Study evaluated each of the case study projects in terms of effectiveness by: (a) comparing the project production benefits expected to be achieved in the original project feasibility study, including hydropower, irrigation, flood control and navigation, with those achieved in practice; and (b) assessing each project’s environmental protection components, including provisions for management of ecosystem degradation hazards and social degradation hazards. This information is summarised in Table ES 3-1.

The project effectiveness may be summed up as follows:

(a) Minimum power generation requirements were met, and on time. In two cases, expectations were exceeded;

(b) Irrigation benefits were less than expected and always late;

(c) Other benefits, even when achieved, were difficult to quantify, including flood control and navigation; none of the projects studied were designed to provide water supplies for urban/industrial needs;

(d) Reservoir sedimentation was a significant problem in one of the four cases;

(e) Disease hazards during the construction/operation periods were not given meaningful attention in two of the four cases;

(f) Resettlement planning provisions were not adequate in all four cases, especially with regard to maintenance or improvement of livelihood;

(g) Inadequate attention was given to the impacts on riverine eco-systems, including fisheries, in all four projects;

(h) For some projects, inadequate attention was given to the problems of erosion/deforestation in the upper watershed areas, including the effects on terrestrial wildlife.
### Table ES 3-1: Planned and Actual Benefits of the Case Study Projects

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Nam Ngum 1 Planned</th>
<th>Nam Ngum 1 Actual</th>
<th>Victoria Planned</th>
<th>Victoria Actual</th>
<th>Magat Planned</th>
<th>Magat Actual</th>
<th>Lingjintan Planned</th>
<th>Lingjintan Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power generation</td>
<td>Principal purpose</td>
<td>Target exceeded</td>
<td>Principal purpose</td>
<td>Power per year</td>
<td>Secondary</td>
<td>Target exceeded</td>
<td>Primary purpose</td>
<td>Too early to say</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>60% of planned</td>
<td>purpose</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Irrigation</td>
<td>Included in planning</td>
<td>Not effective</td>
<td>Included in planning</td>
<td>Benefits fell short</td>
<td>Primary purpose</td>
<td>Benefits fell short</td>
<td>Not a purpose</td>
<td>Not significant</td>
</tr>
<tr>
<td>Navigation</td>
<td>Included in planning</td>
<td>No benefit</td>
<td>Not a purpose</td>
<td>Not relevant</td>
<td>Not a purpose</td>
<td>Not relevant</td>
<td>Included in planning</td>
<td>Successful with some shortfalls</td>
</tr>
<tr>
<td>Flood control</td>
<td>Included in planning</td>
<td>Some benefit realised</td>
<td>Not a purpose</td>
<td>Not relevant</td>
<td>Included in planning</td>
<td>Benefits observed</td>
<td>Part of upstream water control</td>
<td>Insufficient storage for flood control</td>
</tr>
<tr>
<td>Re-regulation</td>
<td>Not a purpose</td>
<td>Not relevant</td>
<td>Not a major purpose</td>
<td>Part of Mahaweli scheme</td>
<td>Not a purpose</td>
<td>Diversion dams not as reservation ponds</td>
<td>Significant purpose</td>
<td>Expected to operate as planned</td>
</tr>
<tr>
<td>Released GHG emission</td>
<td>Not planned</td>
<td>Did replace thermal generation</td>
<td>Not planned</td>
<td>Was an alternative to thermal generation</td>
<td>Included in planning</td>
<td>Not measured</td>
<td>Was included in planning</td>
<td>Was an alternative to burning coal</td>
</tr>
<tr>
<td>Tourism</td>
<td>Mentioned in feasibility study but not planned</td>
<td>Signs of tourism starting</td>
<td>Not planned</td>
<td>Some tourism disrupted by security problems</td>
<td>Not planned</td>
<td>Some tourism in evidence</td>
<td>Was included in planning</td>
<td>Too early to say</td>
</tr>
<tr>
<td>Fisheries</td>
<td>Not planned</td>
<td>Significant development</td>
<td>Not planned</td>
<td>Reservoir fisheries developed</td>
<td>Included in planning</td>
<td>Reservoir fisheries developed</td>
<td>Minor mention in planning</td>
<td>Fisheries disrupted during construction</td>
</tr>
<tr>
<td>Recreation</td>
<td>Not planned</td>
<td>Not relevant</td>
<td>Not planned</td>
<td>Not relevant</td>
<td>Included in planning</td>
<td>Some development</td>
<td>Not planned</td>
<td>Too early to say</td>
</tr>
<tr>
<td>Municipal water supply</td>
<td>Not planned</td>
<td>Not relevant</td>
<td>Not planned</td>
<td>Not relevant</td>
<td>Included in planning</td>
<td>Some development</td>
<td>Not planned</td>
<td>Not relevant</td>
</tr>
<tr>
<td>Rural electrification</td>
<td>Included in planning</td>
<td>Limited success</td>
<td>Included in Planning</td>
<td>Part of Mahaweli electrification</td>
<td>Included in planning</td>
<td>Carried out</td>
<td>Included in planning</td>
<td>Under development</td>
</tr>
<tr>
<td>National development</td>
<td>Significant purpose</td>
<td>Successful planning</td>
<td>Part of planning</td>
<td>Contributed almost as planned</td>
<td>Part of planning</td>
<td>Limited contribution to rural development</td>
<td>Primary purpose was regional development</td>
<td>Too early to say</td>
</tr>
</tbody>
</table>
Table ES 3-1: Planned and Actual Benefits of the Case Study Projects (Cont’d)

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Nam Ngum 1</th>
<th>Victoria</th>
<th>Magat</th>
<th>Lingjintan</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Planned</td>
<td>Actual</td>
<td>Planned</td>
<td>Actual</td>
</tr>
<tr>
<td>Regional development</td>
<td>Significant purpose</td>
<td>Successful</td>
<td>Part of planning</td>
<td>Successful</td>
</tr>
<tr>
<td>Development of the immediate reservoir area</td>
<td>Not planned</td>
<td>Only unplanned inflows of settlers</td>
<td>Not planned</td>
<td>Part of whole Mahewali development</td>
</tr>
<tr>
<td>Electricity exports</td>
<td>Expected</td>
<td>Most significant</td>
<td>Not planned</td>
<td>Not relevant</td>
</tr>
<tr>
<td>EIRR</td>
<td>3.40 per cent</td>
<td>9.33 per cent</td>
<td>11.86 per cent</td>
<td>6.59 per cent</td>
</tr>
</tbody>
</table>

Economic rate of return: The actual rates of return were lower than the expected rates for 3 out of the 4 projects studied. The main reasons were, the actual power generation was lower than the planned level and, the delay in developing irrigation and construction cost overruns. The exception was the case of Nam Ngum 1 where export of the power generated helped to raise the rate of return to a higher level than expected. In the case of Lingjintan, the “actual” rate of return is lower than the planned due to a delay of 3 years in the timing of first generation compared to the planned assumptions.

ES 4. Lessons Learnt (Report Chapter 4) and Recommended Practices (Report Chapter 5)

ES 4.1 Discussion

Analysis of the likely reasons for shortfalls in project effectiveness of the case study projects, as summarised in Table ES 3-1, leads to the conclusion that the basic cause is inadequacies in the processes employed in the development of the projects. This is best illustrated by comparing the actual development processes adopted in the case study projects against a suggested comprehensive project development process.

Figure ES 4-1 illustrates such a comprehensive project development process, by which a project is developed in stages from the establishment of its need, in relation to national policies, through to construction and operation, with relevant technical, economic, environmental and social inputs and appropriate public participation at each stage, and major decisions made at certain points in the process.
Figures ES 4-2, ES 4-3, ES 4-4 and ES 4-5 indicate, using Figure ES 4-1 as a template, the actual development processes employed in the case study projects, in which the activities and inputs not employed are shaded. Additional processes are indicated by italic. Many of the shortfalls in the performance of the Nam Ngum, Victoria and Magat projects noted in Table ES 3-1 can be attributed to inadequacies in the development process. Linjingtan, the most recent project to be implemented, employed a more comprehensive development process, but it was not fully operational at the time of the case study. Therefore, it is not possible to judge whether its more comprehensive process will lead to fewer shortfalls in performance, although indications are that this will be so.
Figure ES 4-1: Model Project Development and Decision-making Process

- **National Policies**
  - Macro-economic Analysis

- **NEEDS EVALUATION**
  - Decision on need

- **OPTIONS ASSESSMENT**
  - Selection of options

- **PRE-FEASIBILITY STUDY**
  - Decision, with public participation, on preferred scheme

- **FEASIBILITY STUDY**
  - Decision, with public participation, to proceed with project

- **FINAL DESIGN**
  - Decision to construct

- **CONSTRUCTION**
  - Construction supervision
  - Environmental protection
  - Social measures
  - Compliance monitoring
  - Public liaison

- **OPERATION**
  - Decisions on basis of monitoring and evaluation

- **Continuing:**
  - Livelihood improvement
  - Environmental protection
  - Monitoring and periodic project evaluation
Figure ES 4-2: Nam Nugm 1 Development and Decision – Making Process

National Policies
Macro-economic Analysis

Strategic EIA
Preliminary EIA for ecology
Sector system analysis
Public consultations

Decision on need

NEEDS EVALUATION

OPTIONS ASSESSMENT (this was done during the feasibility study)

Selection of options

PRE-FEASIBILITY STUDY

Decision, with public participation, on preferred scheme

FEASIBILITY STUDIES
1962-1973-1980 respectively first, second and third stage, respectively

Decision, with public participation, to proceed with project

FINAL DESIGN
(final design for stage I in 1968)

Decision to construct

CONSTRUCTION

OPERATION
(1971)

Decisions on basis of monitoring and evaluation

Emergency evacuation
Construction supervision
Environmental protection
Social measures
Compliance monitoring
Public liaison
Cost/economic monitoring

Continuing:
Resettlement programme
Livelihood improvement
Environmental protection
Monitoring and periodic project evaluation

Minimum social impact assessment
Engineering design

Environmental planning
Social planning
Cost/economic review
Public liaison

Comparison with a thermal alternative
Engineering studies

Engineering options
Socio-environmental assessment
Cost/economic analysis
Public consultations

Strategic EIA
Project EIA
Cost/economic analysis
Public discussion

Cost/economic analysis
Public discussions

Comparison with a thermal alternative
Engineering studies

Minimum social impact assessment
Engineering design

Environmental planning
Social planning
Cost/economic review
Public liaison

CONSTRUCTION

OPERATION
(1971)

Decisions on basis of monitoring and evaluation

Emergency evacuation
Construction supervision
Environmental protection
Social measures
Compliance monitoring
Public liaison
Cost/economic monitoring

Continuing:
Resettlement programme
Livelihood improvement
Environmental protection
Monitoring and periodic project evaluation

Strategic EIA
Preliminary EIA for ecology
Sector system analysis
Public consultations

Decision on need

NEEDS EVALUATION

OPTIONS ASSESSMENT (this was done during the feasibility study)

Selection of options

PRE-FEASIBILITY STUDY

Decision, with public participation, on preferred scheme

FEASIBILITY STUDIES
1962-1973-1980 respectively first, second and third stage, respectively

Decision, with public participation, to proceed with project

FINAL DESIGN
(final design for stage I in 1968)

Decision to construct

CONSTRUCTION

OPERATION
(1971)

Decisions on basis of monitoring and evaluation

Emergency evacuation
Construction supervision
Environmental protection
Social measures
Compliance monitoring
Public liaison
Cost/economic monitoring

Continuing:
Resettlement programme
Livelihood improvement
Environmental protection
Monitoring and periodic project evaluation

Strategic EIA
Preliminary EIA for ecology
Sector system analysis
Public consultations

Decision on need

NEEDS EVALUATION

OPTIONS ASSESSMENT (this was done during the feasibility study)

Selection of options

PRE-FEASIBILITY STUDY

Decision, with public participation, on preferred scheme

FEASIBILITY STUDIES
1962-1973-1980 respectively first, second and third stage, respectively

Decision, with public participation, to proceed with project

FINAL DESIGN
(final design for stage I in 1968)

Decision to construct

CONSTRUCTION

OPERATION
(1971)

Decisions on basis of monitoring and evaluation

Emergency evacuation
Construction supervision
Environmental protection
Social measures
Compliance monitoring
Public liaison
Cost/economic monitoring

Continuing:
Resettlement programme
Livelihood improvement
Environmental protection
Monitoring and periodic project evaluation

Strategic EIA
Preliminary EIA for ecology
Sector system analysis
Public consultations

Decision on need

NEEDS EVALUATION

OPTIONS ASSESSMENT (this was done during the feasibility study)

Selection of options

PRE-FEASIBILITY STUDY

Decision, with public participation, on preferred scheme

FEASIBILITY STUDIES
1962-1973-1980 respectively first, second and third stage, respectively

Decision, with public participation, to proceed with project

FINAL DESIGN
(final design for stage I in 1968)

Decision to construct

CONSTRUCTION

OPERATION
(1971)

Decisions on basis of monitoring and evaluation

Emergency evacuation
Construction supervision
Environmental protection
Social measures
Compliance monitoring
Public liaison
Cost/economic monitoring

Continuing:
Resettlement programme
Livelihood improvement
Environmental protection
Monitoring and periodic project evaluation

Strategic EIA
Preliminary EIA for ecology
Sector system analysis
Public consultations

Decision on need

NEEDS EVALUATION

OPTIONS ASSESSMENT (this was done during the feasibility study)

Selection of options

PRE-FEASIBILITY STUDY

Decision, with public participation, on preferred scheme

FEASIBILITY STUDIES
1962-1973-1980 respectively first, second and third stage, respectively

Decision, with public participation, to proceed with project

FINAL DESIGN
(final design for stage I in 1968)

Decision to construct

CONSTRUCTION

OPERATION
(1971)

Decisions on basis of monitoring and evaluation

Emergency evacuation
Construction supervision
Environmental protection
Social measures
Compliance monitoring
Public liaison
Cost/economic monitoring

Continuing:
Resettlement programme
Livelihood improvement
Environmental protection
Monitoring and periodic project evaluation

Strategic EIA
Preliminary EIA for ecology
Sector system analysis
Public consultations

Decision on need

NEEDS EVALUATION

OPTIONS ASSESSMENT (this was done during the feasibility study)

Selection of options

PRE-FEASIBILITY STUDY

Decision, with public participation, on preferred scheme

FEASIBILITY STUDIES
1962-1973-1980 respectively first, second and third stage, respectively

Decision, with public participation, to proceed with project

FINAL DESIGN
(final design for stage I in 1968)

Decision to construct

CONSTRUCTION

OPERATION
(1971)

Decisions on basis of monitoring and evaluation

Emergency evacuation
Construction supervision
Environmental protection
Social measures
Compliance monitoring
Public liaison
Cost/economic monitoring

Continuing:
Resettlement programme
Livelihood improvement
Environmental protection
Monitoring and periodic project evaluation
Figure ES 4-3: Victoria Development and Decision – Making Process

- National Policies - Macro-economic Analysis
- Energy sector system analysis
- Strategic EIA - Sector system analysis
- Public consultations

Needs Evaluation
- Decision on need

Options Assessment
- Decision, with public participation, on preferred scheme

Pre-Feasibility Study (1978)
- Decision, with public participation, to proceed with project

Feasibility Study (not available)

Final Design (Report on additional work, 1979)
- Decision to construct

Construction

Operation
- Decisions on basis of monitoring and evaluation

Continuing:
- Livelihood improvement
- Environmental protection
- Monitoring and periodic project evaluation

Resettlement planning
- Engineering design
- Environmental planning
- Social planning
- Cost/ Economic review
- Public liaison

Resettlement compensation
- Construction supervision
- Environmental protection
- Social measures
- Compliance monitoring
- Public liaison
- Cost/ economic monitoring

Resettlement assessment
- Engineering options
- Socio-environmental assessment
- Cost/economic evaluation
- Public consultations

Project EIA
- Cost/economic analysis
- Public discussion
- Environmental and social impact studies

Resettlement assessment
- Public consultations

Energy sector system analysis
- Strategic EIA
- Sector system analysis
- Search for alternatives
- Environment assessment
- Public consultations

OPERATION
- Decision to construct
- Decisions on basis of monitoring and evaluation

CONSTRUCTION
- Decision to construct
- Decisions on basis of monitoring and evaluation

FEASIBILITY STUDY (not available)
- Decision, with public participation, to proceed with project

PRE-FEASIBILITY STUDY (1978)
- Decision, with public participation, on preferred scheme

OPTIONS ASSESSMENT (actually carried out during the needs evaluation process)
Figure ES 4-4: Magat Development and Decision – Making Process

1. National Policies
   - Macro-economic Analysis

2. NEEDS EVALUATION
   - Decision on need

3. OPTIONS ASSESSMENT
   - Selection of options

4. PRE-FEASIBILITY STUDY
   - Decision, with public participation, on preferred scheme

5. FEASIBILITY STUDY
   - Decision, with public participation, to proceed with project

6. FINAL DESIGN
   - Decision to construct

7. CONSTRUCTION
   - Resettlement programme
   - Construction supervision
   - Environmental protection
   - Social measures
   - Compliance monitoring
   - Public liaison
   - Cost/economic monitoring

8. OPERATION
   - Decisions on basis of monitoring and evaluation

9. Continuing:
   - Livelihood improvement
   - Environmental protection
   - Monitoring and periodic project evaluation

10. OPTIONS ASSESSMENT
    - Engineering options
    - Socio-environmental assessment
    - Cost/economic evaluation
    - Public consultations

11. FEASIBILITY STUDY
    - Energy sector analysis
    - Engineering studies
    - Project EIA
    - Cost/economic analysis
    - Comparison with a thermal alternative
    - Public discussion
    - Simplified environmental and Social impact studies

12. FINAL DESIGN
    - Energy sector analysis
    - Engineering studies
    - Project EIA
    - Cost/economic analysis
    - Comparison with a thermal alternative
    - Public discussion
    - Simplified environmental and Social impact studies
Figure ES 4-5: Lingjintan Development and Decision – Making Process

National Policies
Macro-economic Analysis

Environmental assessment
Strategic EIA
Sector system analysis
Public consultations
Search for alternatives

Energy sector analysis

Decision on need

Options assessment

Selection of options discussed in the feasibility study

Pre-feasibility study (1988)

Decision, with public participation, on preferred scheme

Feasibility study

Decision, with public participation, to proceed with project

Final design

Decision to construct

Construction

Environmental protection
Social measures
Compliance monitoring
Public liaison

Resettlement process
Construction supervision

Environmental protection
Social measures
Compliance monitoring
Public liaison

Operational

Decisions on basis of monitoring and evaluation

Continuing:
Livelihood improvement
Environmental protection
Monitoring and periodic project evaluation

Resettlement planning
Engineering design
Environmental planning
Social planning
Cost/economic review
Public liaison

Environmental and social impact studies
Engineering studies
Project EIA
Cost/economic analysis
Public discussion
Comparison with a thermal alternative (coal)
Energy sector analysis

Cost/economic analysis
Public discussion
Comparison with a thermal alternative (coal)
**ES 4.2 Main Lesson Learnt**

From the foregoing discussion, the main lesson learnt from the case studies is that significant deficiencies in the performance of a project arise when its development and decision-making process fails to include all the required steps and activities of a comprehensive, progressive project development process in which engineering, social and environmental aspects are co-ordinated.

**ES 4.3 Main Recommendation**

A comprehensive project development process should be adopted in all dam projects, similar to that depicted in Figure ES 4-1, which has the following characteristics:

(a) a progressive development of the project commencing with evaluation of the needs and options assessment, and proceeding through feasibility studies, design, and construction, in which technical, economic, social and environmental issues are co-ordinated, with well-defined decision points in the process.

(b) appropriate public and agency participation at all stages of the process.

(c) continuation of the process into the operational phase of the project to permit monitoring of project effectiveness and remedial action as necessary.

**ES 4.4 Supporting Lessons Learnt and Recommended Practices**

A number of supporting lessons learnt and associated recommendations for dealing with them arise from the main lesson learnt and main recommendation above.

These are summarised in Table ES 4-1 below.

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**Table ES 4-1 : Lessons Learnt/Recommended Practices**

<table>
<thead>
<tr>
<th>Lessons Learnt (Report Chapter 4)</th>
<th>Recommended Practices (Report Chapter 5)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>I. Policy and Institutional Framework</strong></td>
<td><strong>1. Policy and Institutional Framework</strong></td>
</tr>
<tr>
<td><strong>1.1 Water Resources Policy</strong></td>
<td><strong>1.1 Water Resources Policy</strong></td>
</tr>
<tr>
<td>(a) Responsibilities of the project operator rarely cover the whole river basin, and there is often an unclear division of responsibilities especially in multipurpose projects.</td>
<td>(a) There is a need to establish a clear division of responsibilities within each river basin for the co-ordination of planning, implementation and operation of large dam projects.</td>
</tr>
<tr>
<td>(b) The financial benefits accruing to operating agencies are rarely available for social development and environmental protection measures.</td>
<td>(b) Project proposals for the development of large dams must include provision in the project budget for the costs of measures for environmental management, resettlement and improvement of livelihoods.</td>
</tr>
</tbody>
</table>
### 1.2 Energy Policy

It may not be possible for the full capability of hydropower projects to be utilised in the system if they are developed independently of the national energy policy.

### 1.3 Resettlement Policy

Insufficient attention is given to recognition of the rights of people and their communities living in a project area.

### 1.4 Environmental Policy

(a) Insufficient attention is paid in project design to avoid adverse environmental effects of dam discharges, including water quality issues, reservoir pollution from industrial development and human wastes, biodiversity and wildlife issues, and reservoir and downstream fisheries.

### 1.5 Institutional Management

Generally, the projects could have benefited from better institutional arrangements.

### 2. Project Planning and Design

#### 2.1 Water Resources Planning

(a) Sufficient attention is not paid to co-ordination with land-use planning and the development of appropriate operating policies.

(b) Water resource projects often do not deliver their expected benefits due to inaccurate estimates of river flow and the subsequent invalidation of assumptions regarding upstream water diversion and abstraction during the operational phase.
### 2.2 Hydropower Planning

<table>
<thead>
<tr>
<th>(a)</th>
<th>Failure to carry out a comprehensive options assessment is an obstacle to public acceptance of a hydropower project.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(b)</td>
<td>The effectiveness of a hydropower project is not assured unless it has a role in the electric power system in which it operates.</td>
</tr>
<tr>
<td>(c)</td>
<td>The central power utility is best qualified to determine the duties required of a hydropower project.</td>
</tr>
<tr>
<td>(d)</td>
<td>Environmental and social impacts are issues that need to be considered in the planning of all dam projects.</td>
</tr>
<tr>
<td>(e)</td>
<td>The cost of transmission could make a significant difference when comparing hydropower schemes with a thermal alternative.</td>
</tr>
<tr>
<td>(f)</td>
<td>A hydropower scheme often does not provide electrification benefits to the communities living in the immediate area of the dam and reservoir.</td>
</tr>
<tr>
<td></td>
<td>To increase the reliability of inputs, the estimate of the sediment accumulation in the reservoir should take into account the potential future changes in forest cover and land use, and further engineering research should be undertaken on the means of removing sediment from reservoirs.</td>
</tr>
<tr>
<td></td>
<td>Water resources projects should always fairly consider the downstream users particularly in situations where water rights law is poorly developed and enforced.</td>
</tr>
<tr>
<td></td>
<td>Prior to conducting feasibility studies, hydropower projects should be compared with alternative power generation options including the environmental impacts associated with each option.</td>
</tr>
<tr>
<td></td>
<td>Before adopting a hydropower project, the decision-makers should determine whether it fits into the least-cost expansion plan for the country or region concerned.</td>
</tr>
<tr>
<td></td>
<td>The power utility should be directly involved in the planning of a hydropower project.</td>
</tr>
<tr>
<td></td>
<td>In undertaking a series of layout studies before making a definitive selection of a particular layout of a hydropower project, the environmental and social impacts of the various layouts should be taken into account.</td>
</tr>
<tr>
<td></td>
<td>Generation expansion plans should be accompanied by transmission and distribution plans.</td>
</tr>
<tr>
<td></td>
<td>Provision of a medium voltage supply to local communities in the project area should be considered as an essential part of a hydropower scheme.</td>
</tr>
</tbody>
</table>
2.3 Other Water Resources Use Planning

Project planning has a tendency to focus on the main purpose of the project (e.g., hydropower) and often does not maximise all the other water resources benefits possible.

2.4 Engineering Design

The selection of a design does not always give due consideration to design alternatives which enable more effective mitigation of environmental and other negative impacts.

2.5 Social Impact Assessment and Mitigation

(a) There is often only limited participation of the local population in the planning and decision-making of the studied projects, even in relation to resettlement options.

(b) Social impact assessments often do not cover the whole possible spectrum of “project affected persons.”

(c) Failure to undertake timely baseline surveys (to establish the social and economic conditions of project affected persons) for consideration in the

(g) The energy benefits from a hydropower project in a cascade of dams may be greater than the actual power generated from the project.

(g) Consideration of the overall energy benefits of a hydropower scheme should take into account the occurrence of any changes in operations of other dams in a cascade on the same river.

(h) Existing dams should be considered when comparing the possible options for power generation.

2.3 Other Water Resources Use Planning

(a) Future dam planning should consider the full range of options in a multipurpose development project.

2.4 Engineering Design

(a) Before the final dam type is selected, it is important to ensure that all positive and negative impacts are included in the comparison, and that the corresponding field and laboratory data are available in sufficient detail and accuracy.

(b) The final dam site and the entire project layout should be optimised in order to ensure that the most adequate and least-cost arrangement of the project component has been made.

2.5 Social Impact Assessment and Mitigation

(a) Appropriate public participation should be an integral part of the overall project planning process, and resettlement planning should be based on the principle that affected persons should be better off after relocation.

(b) Early consultation with the people who are likely to be affected by dam and reservoir construction and operation should be mandatory, and should reflect local customs.

(c) Identification and eligibility of project affected persons should be based on comprehensive reconnaissance studies (based on preliminary social assessment).
feasibility stage of project development can jeopardise plans for the restoration of livelihoods.

(d) Inadequate attention is paid to the population dynamics of project affected persons.

(e) There are gaps in rights to compensation.

(f) Settlement plans tend to emphasise infrastructure development at the expense of livelihood development.

(g) Resettlement costs substantially exceed predicted levels.

2.6 Environmental Impact Assessment and Mitigation

(a) Project planning often gives inadequate attention to effects on the eco-system, including issues of water quality, impacts on fisheries, etc.

(b) The approval requirement does not always make effective use of the EIA process (covering ecological, sociological, and economic issues).

(c) Insufficient attention is given to the impacts of inundation on water quality in the reservoir and downstream releases.

(d) The overall project plan often does not take into account the potential for serious pollution of the reservoir water by industrial operations and discharges of sewage and other wastewater.

(d) A baseline survey, incorporating a detailed livelihood analysis, should be a constituent element of the resettlement plan.

(e) Eligibility for compensation should be inclusive, based on needs and not the possession of legal rights documentation.

(f) Resettlement plans for displaced project affected persons should deal with the full range of socio-economic development of the receiving areas.

(g) Resettlement planning must consider any losses of income and resources (e.g. water supply, downstream fisheries), not just the loss of land or housing.

2.6 Environmental Impact Assessment and Mitigation

(a) Consideration of the environmental aspects should cover all stages of project planning, with the degree of depth of study matching the study scope.

(b) The EIA study must be an essential part of the project feasibility study.

(c) An Environmental Management Office should be established by the project owner/proponent, following the approval of the feasibility study/EIA, and should have the responsibility for accomplishing all the environmental protection measures, including environmental monitoring programmes.

(d) The EIA study of each large dam should cover the significant aspects of watershed conservation and management, and the crafting of a suitable watershed management plan responsive to project-specific site conditions.
(e) EIA documentation does not sometimes adequately consider the critical biodiversity and wildlife aspects (such as population levels and their livelihood activities) in projecting the biodiversity impact.

(f) A net assessment of environmental and social costs vis-à-vis the environmental benefits, which can lead to a more judicious appraisal of overall environmental soundness of a dam project is often not carried out.

(e) Generally, adverse environmental impacts with a high probability of occurring during project construction and operation will need to be controlled by appropriate environmental protection measures (including mitigation measures).

(f) The various water quality problems that may arise from dam construction and operation must be considered carefully during the project planning stage. This is necessary to ensuring feasible solutions when designing a dam and its outlet system as well as in the operation and maintenance of those facilities.

(g) The more serious adverse impacts on downstream fisheries and potential reservoir-related fisheries benefits in the planning and operation of a dam project must be carefully evaluated in the project planning process.

(h) Biodiversity conservation efforts undertaken in dam watershed areas must be reconciled with the need of the local communities to obtain subsistence requirements from the watersheds, while engaging in the sustainable use of forests and forestry products through ecologically responsible practices. This includes, for example, the use of soil and water conservation in agroforestry activities.

(i) The hazard of an increased incidence of malaria and other diseases can be addressed through remedial measures such as anti-malarial spraying campaigns and the implementation of other preventive measures.

2.7 Economic and Financial Evaluation

(a) Access to financial resources for dam construction was not so much of a problem in any of the four case studies as it may generally prove to be today.

2.7 Economic and Financial Evaluation

(a) A more complete analysis of the costs and benefits of dams in a sectoral planning model is required. The benefits should be valued according to project objectives and then quantified, including the macroeconomic, regional and developmental impacts.
(b) The four case study dams were not planned according to a sectoral model for the power sector.

(c) Financial analyses were lacking in the case studies because they were all government projects.

(d) The economic analysis did not include adequate consideration of social and environmental costs.

(e) Furthermore few cases were found where the distribution of benefits and costs was estimated, and where the project risks were assessed as part of the study.

3. Project Implementation

3.1 Construction
The major issues in construction are delays in completion and over-runs in cost.

3.2 Rehabilitation of Affected Persons
(a) Delays in land development lead to delayed livelihood restoration.

(b) Land-based livelihood improvement strategies tend to be too narrowly based.

(c) Agricultural development strategies concentrated on monoculture of low-value crops.

(b) Even for government projects a full financial analysis based on the marginal cost of untied funds to the public sector should be carried out. A financial analysis is required for each affected group, to ensure that they will not be disadvantaged by the project but will actually share fairly in the project benefits.

(c) Economic analysis should include adequate consideration of social and environmental costs and benefits. However, environmental costs and benefits may be difficult to quantify.

(d) Benefit sharing among stakeholders and analysis of costs and benefits for separate groups of stakeholders is essential. Cost benefit analysis should be used for more participation and gaining public acceptance.

(e) Accounting for risks in project costs and benefits should be carried out as a sensitivity analysis.

3. Rehabilitation of Affected Persons
(a) The relocation of project affected persons should be carried out in accordance with the schedule for reservoir filling, and in accordance with a separate schedule for the re-establishment of livelihoods.

(b) The improvement of livelihoods of project affected persons should be the objective of the preparation of development plans.

(c) Lessons should be learnt from the general experiences of agricultural development, especially in resource-poor areas, and applied to the planning of agricultural development options for resettlement.
(d) Ethnic minorities have greater difficulty in adopting, and adjusting to, new livelihoods.

(e) Pressures on the agricultural system may be reduced through a well-planned alternative to a land-based development strategy.

(f) Development of non-farm employment has been neglected.

(g) Social service provision has not kept pace with the creation of social infrastructure.

(h) Livelihood development is a long-term strategy and was not adequately addressed.

(i) Provisions for bridging the income gap until livelihood development is achieved have been inadequate.

3.3 Environmental Mitigation

(a) Dam discharges create adverse environmental impacts that must be actively addressed.

(b) Greater attention should be given to addressing the impacts of inundation on water quality in reservoirs and downstream releases.

(c) The inundation of forested areas along stream corridors (riparian forests) leading to the reservoir area cause significant ecological impacts, both on biodiversity and wildlife resources.

(d) Livelihood improvement strategies for minority groups in particular should attempt to rebuild traditional systems.

(e) Fisheries and aquaculture development potential, both in the reservoir areas and as an element of diversification in the agricultural system, should be exploited.

(f) Non-farm employment opportunities, based on a regional economic analysis, should be developed.

(g) The resettlement authorities should coordinate their efforts with social development agencies, whether these are governmental or non-governmental organisations.

(h) Rehabilitation should continue on a funded basis well past the construction completion date.

(i) Any income gap prior to full development of new agricultural lands or provision of replacement job opportunity should be covered through household income support in cash or in kind; households should not be worse off during the transition period.

3.3 Environmental Mitigation

(a) The TOR for the EIA study on each large dam should cover the significant aspects of environmental protection and watershed conservation/management as well as the crafting of a realistic and suitable watershed management plan that is responsive to project-specific site conditions.

(b) An Environmental Management Office should be established by the project owner/proponent following the approval of the feasibility study/EIA.

(c) Generally, adverse environmental impacts with a high probability of occurring during project construction and operation need to be controlled through appropriate protection and mitigation measures.
(d) The dam and reservoir projects have contributed to sub-optimal conditions that have been implicated in declines in downstream fisheries productivity.

(e) The dams have obstructed the passage of migratory fish species, resulting in serious losses of valuable species.

(f) Reservoir fisheries were not adopted as a strategy to offset downstream fisheries facing productivity declines. There is a need to supplant subsistence fishing by the local community with a more ecologically sustainable form of fishing, in terms of a judicious mix of incentives and disincentives (e.g., regulated harvesting and seasonal yield protocols and stricter monitoring and enforcement).

(g) Biodiversity conservation efforts undertaken in dam watershed areas must be reconciled with the need of the local communities to obtain subsistence requirements from the watersheds, while engaging in the sustainable use of forests and forestry products through ecologically responsible practices. This includes, for example, the use of soil and water conservation in agroforestry activities.

(h) EIA should involve the preparation of an Environmental Impact Mitigation action plan.

(i) Dam and reservoir projects must also develop an appropriate watershed management plan, although some dams on large watersheds could not realistically develop or implement such a plan.
3.4 Cost Control
There were significant cost overruns in project construction.

4. Project Operation and Monitoring
4.1 Technical Monitoring and Review
(a) The operation of the large dam projects are influenced by criteria other than primary purpose.

(b) The operation of a hydropower plant may evolve to comply with changes in the economic and political context.

(c) Dam safety facilities and a dam safety program are not actively in place in many dams.

4.2 Environmental Monitoring and Evaluation
(a) Dam discharges created relevant environmental issues that need to be actively addressed.

(b) The dams have obstructed the passage of migratory fish species, resulting in serious losses of valuable species.

(j) Clearing the reservoir area of vegetative cover (such as trees) and other organic matter before the area is flooded with water is an ecologically sound procedure that should be carried out prior to the operation of the dam.

3.4 Cost Control
Cost sharing in the construction and operation of a dam must be transparent. It must be applied with financial discipline and use cost recovery as a yardstick.

4. Project Operation and Monitoring
4.1 Technical Monitoring and Review
(a) Releases from dams should take into account both energy and irrigation requirements as well as flood control and downstream needs.

(b) When a hydropower project is part of a river basin development plan, its operation should be adapted to optimise the energy benefits at the river basin level, and should be flexible enough to adapt to potential changes in the economic or political context of a country.

(c) Instrumentation to monitor the behaviour of a dam should be installed (or retro-fitted in an existing dam), and a dam surveillance program instituted so that the safety of the dam can be assured throughout its life.

4.2 Environmental Monitoring and Evaluation
(a) The project monitoring and evaluation component of an EIA study should include an operation phase environmental impact monitoring and evaluation programme.

(b) Baseline environmental (ecological) surveys for upstream and downstream areas are needed as part of the environmental monitoring and evaluation component of the EIA study on each large dam project. Such surveys are also needed as part of the formulation and implementation of an environmental management programme for each project.
(c) The dam and reservoir projects have contributed to sub-optimal conditions that have been implicated in declines in downstream fisheries productivity.

(d) Reservoir fisheries were not adopted as a strategy to (i) offset declines in downstream fisheries productivity and (ii) supplant subsistence fishing for the local community.

(e) A net assessment of environmental and social costs vis-à-vis the environmental and social benefits through a systematic environmental monitoring and evaluation programme was not carried out in the case study projects.

4.3 Social and Resettlement Monitoring and Evaluation

(a) Project evaluation carried out too soon after the completion of construction cannot adequately reflect significant social concerns

(b) The long-term process of capacity building was not evident in the cases studied.

4.4 Financial and Economic Re-evaluation

The divergence of expected and actual performance of the dams is often notable, showing that there is a need to closely monitor the post-construction performance of dam projects.

(e) Lessons, critical observations, useful insights and feedback of information generated by the environmental impact monitoring programme should be properly utilised for adaptive environmental management purposes by the planners and decision-makers in a dam project, in order to further improve overall project planning, management and decision-making. The institutional and legal instruments to effect changes should be based on monitoring feedback. Excellent monitoring data are of little managerial use if there is no apparatus for translating the data into specific actions.

(d) The more serious adverse impacts on downstream fisheries, and potential reservoir-related fisheries must be carefully evaluated in the planning process.

(e) Environmental and social costs must be assessed through a systematic monitoring and evaluation programme.

4.3 Social and Resettlement Monitoring and Evaluation

(a) The improvement of livelihood requires ongoing monitoring together with periodic evaluations of progress that involve mechanisms for feedback to enable relevant actions to be taken.

(b) The monitoring of migrant influx and access (in conjunction with their livelihood activities) should be incorporated into the total environmental and social impact monitoring and evaluation programme.

4.4 Financial and Economic Re-evaluation
<table>
<thead>
<tr>
<th>(a)</th>
<th>Attention was not paid to subsidies.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(b)</td>
<td>Financial and economic performance was not measured adequately.</td>
</tr>
<tr>
<td>(c)</td>
<td>Comparison of pre-project and post-project is difficult for these cases.</td>
</tr>
<tr>
<td>(d)</td>
<td>Financial and economic monitoring of dam performance was inadequate.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(a)</th>
<th>The treatment of subsidies in project appraisal is an important issue and should be given due attention.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(b)</td>
<td>There is a need to work out an adequate system for monitoring the financial and economic performance of large dams.</td>
</tr>
<tr>
<td>(c)</td>
<td>Data should be maintained in a form and format that allows easy comparison of the pre-project and post-project situations.</td>
</tr>
<tr>
<td>(d)</td>
<td>An adequate system needs to be formulated for monitoring the financial and economic performance of large dams.</td>
</tr>
</tbody>
</table>
1. Introduction

1.1. Background

The need for dams that provide water storage, flood mitigation, irrigation, power generation, aquaculture and fisheries, water supply for domestic and industrial use and even benefits for navigation must be balanced against negative environmental and socio-economic impacts. The constraints and challenges that face the search for a balance in the sustainable development of limited freshwater resources are underscored by the findings of the present study as well as those of the related study undertaken by the World Commission on Dams (WCD).

Large dams are only constructed after a planning process that includes the familiar elements of water resource planning, energy planning, environmental impact, socio-economic impact, geotechnical risk assessment and cost-benefit analyses. Yet, as public opposition to the construction of new dams increasingly illustrates, there is real concern as to whether the balance of benefits accruing after construction actually matches the projections made at the planning stage. A balance must be found, as ICOLD has so eloquently pointed out1, since all dams provide both benefits and undesirable environmental and social impacts. Of course, the larger the dam the greater will be the construction costs and impacts involved.

The impact assessments mentioned above are not static unchanging quantities. As the natural and human environment adjusts to the presence of a dam, external factors (such as deforestation) alter the parameters affecting dam performance, while advances in human experience, knowledge and technology provide better insight into dam performance. Thus, the relevance and conclusions of such impact assessments alter with time.

It is also vitally important to ensure that any assessment of the impact of dams is impartial, devoid of any vested interests among those individuals who stand to profit from dam construction (as opposed to benefits to society from the dam itself). At the same time, the uninformed emotion of certain opposition groups must be eschewed. The benefits and the costs must be balanced, with complex social effects factored into the cost-benefit equations.

Developing countries, especially in Asia, are moving towards a critical shortage in water supply, a growth in energy demand and a need for better flood protection. Some difficult decisions on water resource management lie ahead, and it is important that those decisions be taken in as fully informed a way as possible. The decisions must inevitably consider the construction of dams and barrages as well as other water storage and distribution possibilities.

It is now clear that, in the past, decisions to construct large dams have been based on inadequate assessments of positive and negative impacts. Furthermore, project implementation measures aimed at minimising the negative impacts and spreading the benefits of positive impacts over all stakeholders generally have not been adequate.

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Over the past few decades as many as 39,000 dams categorised\(^2\) as “large” have been constructed. A vast body of technological knowledge has thereby been accumulated. However, today, the questions of dam engineering are not the primary issue. It is the economic, social and environmental impacts that now are questioned by locally affected interests, human rights groups and environmental conservationists. Thus, many large dam projects have been planned but are still awaiting implementation (e.g., the Arun III project in Nepal and the Kalabagh project in Pakistan).

The decisions to move ahead with the development of hydropower projects in developing countries are often made by governments and utilities, together with international funding agencies, usually following a least-cost approach. Any least-cost planning approach is normally based on the minimum current worth of investment as well as the operating and maintenance costs over a specified planning period. Such methodologies used in the past have often had a number of drawbacks. For example, such methods do not integrate demand side measures of energy planning. Also, such planning analysis is known to have ignored external costs associated with the control and mitigation of environmental and social impacts.

This situation shows that a great deal of work is still required in adopting safe and sound practices that based on state-of-the-art technology, in order to benefit all stakeholders, satisfy all sections of society, and enhance the social, economic and environmental benefits of dam projects.

1.2. Objectives and Scope of RETA 5828

The overall objective of technical assistance is to formulate, for governments and concerned agencies, recommendations of “best practices” in the assessment of costs and benefits of new large dams as well as the maintenance of existing ones. This overall goal encompasses a hierarchy of more specific objectives such as:

(a) Analyses of predicted and unforeseen problems that have arisen in association with specific large dams;

(b) Syntheses of recommendations for avoiding or alleviating such problems;

(c) The construction of more holistic methodologies for dam cost-benefit analysis,\(^3\) including the factoring in of indicators for measuring complex socio-economic and environmental issues; and

(d) The examination and possibly reformulation of global recommendations related to planning and utilisation of large dams.

\(^2\) According to the criteria of the International Commission on Large Dams World Register, this includes dams that: (a) are higher than 15 m; (b) are higher than 10 m, but with a crest length of more than 500 m; (c) have more than 1 million m\(^3\) storage capacity; or (d) have more than 2,000 m\(^3\)/sec capacity.

The objective of this Study was to draw up a framework of recommendations (relevant to Asia), to enable a decision on whether or not to embark on a large dam project could be made in a fully informed manner. It was to include an objective assessment of the pros and cons of alternative methods of water and energy management. Finally, the framework was to clearly set out any project implementation requirements for minimising negative impacts and ensure that all project affected persons would share the benefits.

1.3. Scope of the Study Methodology

The project was divided into two phases. The first phase comprised a review of relevant literature leading to the selection of dams for further study. The second phase was the study of selected dams and the formation of the required policy observations, statements, guidelines and recommendations.

1.3.1 Phase 1

Phase 1 comprised for main stages:

- An initial literature review, which covered sources supplied by ADB and concerned agencies. In addition, each expert sourced the professional literature relevant to his particular expertise.

- The information and data from the initial literature review was then used to establish criteria for selecting dams for further case studies under Phase 2.

- Using those criteria, the International Consultant Team, Advisory Panel and ADB selected four dams for further study.

- A methodology for the case studies was constructed.

1.3.2 Phase 2

Phase 2 comprised two main stages:

- Individual case studies of four selected dams.

- Using the conclusions reached by the case studies, a set of recommendations and a framework were developed for future decision-making.

In addition, the International Consultant Team provided inputs to the concurrent work programme of WCD.

1.4. The Consultants

The International Consultant Team comprised a consortium of four companies:

(a) Southeast Asia Technology Co., Ltd., Thailand (Lead Firm);
(b) The Asian Institute of Technology Alumni Network Ltd., Hong Kong;
(c) Lahmeyer International GmbH, Germany; and
(d) SCHEMA Konsult, Inc., the Philippines.
The individual international consultants included:

Dr. Sutham Sitthichaikasem SEATEC Team Leader and Environmental Expert
Dr. Harvey Demaine AITA-NET Socio-economic Expert
Dr. Thierry Lefevre AITA-NET Energy Analysis and Planning Expert
Dr. Terence Muir Lahmeyer Water Resources and Hydraulic Structures Expert
Dr. Kris Drabik Lahmeyer Water Resources and Hydraulic Structures Expert
Dr. Charit Tingsabadh SEATEC Economics Expert

They were assisted by:

Dr. Subin Pinkayan SEATEC Adviser
Professor Alastair M. North AITA-NET Adviser
Ms. Somsong Patarapanich SEATEC Project Co-ordinator

The International Consultant Team was guided by an Advisory Panel, which included:

Mr. Ranji Casinader Australia Engineering and Project Development
Mr. John Garcia United States Environmental Issues
Mr. Martin ter Woort Canada Socio-economic Issues
Prof. Anil Markandya United Kingdom Economics.

Once the four dams had been selected for the case studies, the following domestic consultants were appointed.

(a) The Lao PDR, ECOLAO

Mr. Rattanatai Luanglatbandith Socio-economics/Environment Specialist
Mr. Voradeth Phonekeo Water Resources/Energy Planning Specialist
Mr. Garry A. Oughton Land-use Specialist
Mr. Boungnong Singnavong Documentation Expert
Mr. Phouthone Navorath Field Logistics/Liaison Expert

(b) Sri Lanka, AITA-NET

Dr. Ranjith Perera Socio-economics Specialist
Dr. Uditha Ranayake Civil Engineering
Dr. Induka Werellagama Environmental Expert
Dr. Rahula Attalage Energy Analysis and Planning
Ms. Pushpa Ekanayake Economics Specialist
1.5. Methodology

The overall project methodology involved a literature review, selection of four dams for detailed case study, analysis of observations made from the case studies and, finally, a synthesis of the lessons learnt and recommendations for best practices.

Central to this sequence was the methodology of the case studies. The methodology was based on that used by WCD in its own case studies. WCD used two phases: a scoping phase followed by the implementation phase. However, in the present study the very limited time available made it impossible to carry out the study in two separate phases, so that scoping and implementation were combined into a single activity.

The methodology was constructed around the following six key WCD questions:

- What were the projected versus actual benefits, costs and impacts?
- What were the unexpected benefits, costs and impacts?
- What was the distribution of costs and benefits – who gained and who lost?
- How were decisions made?
- Did the project comply with the criteria and guidelines of the day?
- How would the project be viewed in today’s context, in terms of lessons learnt.
The details of the central questions are to be found in “Detailed Methodology for Case Studies” (pages 4-7). Subsidiary questions dealing with the amplification of the central issues are listed in the same document (pages 17-22).

In order to find answers to the six questions, information was sought extensively from relevant literature and other sources prior to the site visit, and then reinforced with further material provided by the Domestic Consultants or collected from appropriate agencies during the visit. Again, the information sources are provided in reference 4, pages 7-10.

An important part of the information collection was structured interviews with stakeholders. The basis of these structured interviews is set out in “Detailed Methodology for Case Studies” (pages 10-13, 15-16 and 23-29).

Significant to the case study methodology was the input by the Domestic Consultants. To that end, a document was prepared, entitled “Terms of Reference for Domestic Consultants”. The document detailed the expected collection of literature and relevant data, organization of site visits and, most importantly, the arrangement of meetings with stakeholders (including affected villagers). Finally, the Domestic Consultants assisted in the preparation of the case study reports through the submission of further material.

The meetings with affected villagers were structured so as to allow free input of comment and information with minimum oversight by authorities. In order to achieve such dialogue, formalities were kept to a minimum. However, the Domestic-International Consultant Team did prepare a set of questions, drawn from the requirements of the project methodology, but also encompassing issues relevant to the dam and settlement under discussion.

1.6. Literature Review

A broad literature search was conducted, both at physical library facilities and through Internet sources. The Bangkok library facilities included those of the Asian Institute of Technology (AIT), the World Bank, Chulalongkorn University and the Economic and Social Commission for Asia and the Pacific (ESCAP), while the Internet sources consulted were many and varied.

The literature review began with a discussion of the growing attention being given to social and environmental issues in relation to large dam construction, with special attention to the policy guidelines issued by the development banks. It then elaborated upon the recognised social and environmental issues. The analysis of social issues identified the different geographic contexts in which the impacts of large dams might occur and then used the “Risks and Reconstruction” model to analyse those impacts. Finally, the evolution of policies for addressing the problems of project affected persons were reviewed, both on a national scale and among the funding agencies. The problems of institutional capacity in translating those policies into procedures and practice were highlighted.

4 ADB RETA 5828 Inception Report, Appendix 4.
Environmental impacts were reviewed in the same manner. Potential impacts were listed and the evidence of impacts, mainly from studies in Thailand, was presented. The nature and contents of the environmental impact assessments (EIA) were described.

Further sections of the literature review dealt with energy planning and hydropower planning, water resource planning and the project design process, and economic issues. The first began with an overview of integrated energy planning and the place of electricity system planning as a part of the overall strategy. It then concentrated on issues in hydropower planning, reviewing different types of hydropower dams and their respective environmental impacts. The section on water resources planning concentrated first on processes, particularly the institutional context for planning, demand forecasting and management and alternative water resource development plans. Attention was given to the increasing role of private developers in the sector and the implications of that trend. The analysis then turned to the specific issue of the design process, including consideration of adequacy of data, sedimentation, different intake levels, spillway capacity and safety, and the question of cost overruns. Finally, questions of project operation were considered. The section on economic issues largely reviewed key references on approaches to the analysis of such projects. Each section of the literature review ended with comments on the methodology to be followed in the main part of the study.\(^5\)

### 1.7. Selection of the Dams for Case Studies

Limitations on time and funds meant that only four dams could be chosen for the present Study. The four dams were selected because they:

(a) Provided the maximum possible number of lessons to be learnt for future decision-making;

(b) Provided illustrations of the largest positive and negative impacts, and other key issues; and

(c) Covered a variety of dam types, ages and geographical locations.

The selection was made by using an iterative process\(^5\) that first constructed a “long short-list” based on maximising available quantitative data such as dam height, reservoir volume, energy generating capacity, number of persons of families resettled etc. The list was then shortened by the application of environmental and socio-economic impact matrices, which, in a qualitative or semi-quantitative way, identified those dams where key environmental and socio-economic factors had been, or are, of significance. Finally, the “short list” was reduced to four dams (with four “back-up” alternatives), by a roundtable discussion of the International Consultant Team and the ADB Panel of Advisers, taking into consideration issues such as widest coverage of dam type and age, geographical spread, ease of access to both pertinent information and the dam site etc.

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\(^5\) ADB RETA 5828 Inception Report, pp. 3-10. Note, in particular, Table 2.1 (147 dams, 42 parameters) and Table 2.2 (10 dams). (Also pp. 77-80.)
1.7.1. Nam Ngum 1

Of the dams chosen using the above criteria, Nam Ngum 1 was identified for the first (pilot) study because, in addition, it provided an excellent example as:

(a) The oldest dam in the group, and was planned and commissioned before EIAs and socio-economic planning became conventional and/or statutory;

(b) A dam for which, over almost 30 years, the dam site environs should have reached an environmental and human settlement equilibrium;

(c) A project for which the long-term economic aspects could be analysed and compared with planning expectations;

(d) A water resource management project for which long-term effects, such as siltation, deforestation of the catchment area etc., could be observed;

(e) A site that could be easily accessible from the International Consultant Team headquarters in Bangkok; and

(f) It would be possible to contract the domestic consultants in the limited time between dam selection and the first site visit.

1.7.2. Victoria

The Victoria dam was selected because it was:

(a) A part of a very complex, but well developed, river basin development scheme (the Mahaweli Development);

(b) The largest hydropower project ever proposed for Sri Lanka; and

(c) Unusual in view of its proximity to a large town (Kandy).

1.7.3. Magat

For the third case study, the International Consultant Team originally selected the Cirata dam in Indonesia. However, at the time of the scheduled site visit (early 2000), riots and political unrest created a security problem and other difficulties for the team. So, despite short notice, it was decided to study the back-up alternative, the Magat dam in the Philippines. In addition to the criteria used to select Magat for the short list of selected dams, a number of other aspects were significant. These included:

(a) The dam and its associated irrigation system were completed some 16 years ago, offering a reasonable perspective on impacts;

(b) The fact that, unlike the other three case study dams, Magat was not built primarily for hydroelectric generation, but rather to stabilise the supply of irrigation water in order to intensify and expand downstream agriculture;
(c) Anticipation that the information available on the dam was likely to be adequate for a rapid and detailed study, particularly given the ease of access and the presence of the associated firm, SCHEMA, in Manila; and

(d) The size of the Magat dam, which is among the biggest in the region, especially with regard to its massive spillway. The irrigation area is also large, with over 100,000 ha of service area.

1.7.4. Lingjintan

The original intention of the Regional Technical Assistance was to conduct case studies of six dams, of which at least two would be those financed by ADB. They were to be selected from four dams that had been the focus of the Special Evaluation Study on the Social and Environmental Impacts of Selected Hydropower Projects (RETA 5793). The study was conducted between November 1998 and January 1999, so that the present study coming only one year later, would constitute a useful update on what were all relatively new dams. The four dams under that study were:

- The Batang Ai Hydropower Project, Sarawak, Malaysia
- The Hunan Lingjintan Hydropower Project, Hunan, China
- The Theun-Hinboun Hydropower Project, Lao PDR
- The Power XX (Singkarak) Project, West Sumatra, Indonesia.

When the number of case studies was reduced to four, originally the international consultants selected the Batang Ai project. However, permission to conduct a further review of Batang Ai with its sensitive ethnic resettlement issues was not granted by the Government of Malaysia. The consultants and their advisory panel felt that at least one dam in China should be included the list of case studies, so that when the number of case studies was reduced, it was thus deemed logical to include Lingjintan. All the ADB dams under the RETA 5793 study were of the run-of-the-river type. However, the Lingjintan dam was the biggest of the four, and its complex relationship with the much larger Wuqiangxi dam provided additional interest in the context of a major strategy for hydropower development in the Yuanshui basin.

The locations of the four selected dams are shown in the map of Asia in Figure 1-1. The four projects provide a good cross-section of dams built for hydropower generation, irrigation, flood control and navigation; however, they do not provide good examples with regard to urban water supply. Given the pace of development in Asia, which is characterised by rapid urbanisation and rising per capita demand through both domestic use and consumption of materials (industrial use), this limitation may well be significant. On the other hand, the observations and recommendations that have been formulated have equal validity for all large dams, regardless of their purposes.
Figure 4-5: Lingjintan Development and Decision – Making Process

1. National Policies
   - Macro-economic Analysis
   - Decision on need

2. Environmental assessment
   - Strategic EIA
   - Sector system analysis
   - Public consultations
   - Search for alternatives
   - Selection of options discussed in the feasibility study

3. Engineering options
   - Socio-environmental assessment
   - Cost/economic evaluation
   - Public consultations
   - Decision, with public participation, on preferred scheme

4. Resettlement planning
   - Engineering design
   - Environmental planning
   - Social planning
   - Cost/economic review
   - Public liaison
   - Decision to proceed with project

5. Resettlement process
   - Construction supervision
   - Environmental protection
   - Social measures
   - Compliance monitoring
   - Public liaison

6. Continuing:
   - Livelihood improvement
   - Environmental protection
   - Monitoring and periodic project evaluation
   - Decisions on basis of monitoring and evaluation

---

PRE-FEASIBILITY STUDY (1988)

FEASIBILITY STUDY

FINAL DESIGN

CONSTRUCTION

OPERATION
Figure 1-1: Case Study
2. Case Study Analysis

This chapter draws together observations on the ways that the four case study projects developed from initial idea to construction, and then to operation. The various discussion issues covered by this chapter include:

(i) project justification,

(ii) project planning, especially hydro plants, including consideration of options or alternatives on dam sites and types,

(iii) institutional framework,

(iv) engineering design process,

(v) financial and economic appraisal,

(vi) the social impact assessment component of the Environmental Impact Assessment (EIA),

(vii) ecological impact assessment component,

(viii) details for project construction for each case, and

Tables 2-1, 2-2 and 2-3 included here summarise the study findings from the study steps described in items (i) to (v) above.

2.1. Institutional Framework

Some common but noteworthy features relevant to the institutional framework for the four projects are the fact that the engineering and design for the projects were internationally sourced, and that the financial wherewithal for undertaking the projects was provided by donors outside of the host countries.

As an early dam in one of the least developed countries of the region, Nam Ngum 1 was largely conceived and implemented with co-ordination by a regional body, the Mekong Committee. The national electric power agency only took over responsibility after the construction period. Both the Magat and Victoria dams relied extensively on international engineering consultants for planning and implementation, although their inputs were much greater at the dam construction stage in the case of Victoria. However, Magat was planned as a one-off project by the National Irrigation Administration (NIA), although dam construction and operations were in the hands of the National Power Corporation (NACPOR). Neither agency had an overall co-ordinating role. The Victoria Dam, on the other hand, was developed within the framework of a major river basin development programme, the Accelerated Mahaweli Development Program, co-ordinated by the specially created Mahaweli Authority of Sri Lanka (MASL). Although the Ceylon Electricity Board (CEB) is responsible for electricity generation and operation of the dam, this is within the wider framework set by MASL. Lingjintan was largely implemented as a national project, mainly for electricity generation. It was thus planned and implemented by the Hunan Electric Power Corporation, latterly through a semi-privatised subsidiary.
All four projects were included as elements of a river-basin planning strategy. However, it was only in the case of the Victoria Dam that the authority of the project owner was sufficiently wide to be effective. The mandate of MASL extends not only to the provision of electricity, but also to the provision of adequate water for downstream irrigation and the river flows, and to management of the watershed and natural resources. The whole Accelerated Mahaweli Development Program attracted widespread international support, which allowed MASL to carry out its mandate.

China has a strategy for hydropower development in the Yuanshui Basin, but this is not a fully integrated strategy. The mandate of the project owner of the Lingjintan Dam, the Wuling Hydropower Development Corporation (WHDC), at present only extends to the operation of one part of the cascade (the Wuqiangxi and Lingjintan dams). Wuling, as a semi-privatised corporation, has no responsibility for overall river basin management. However, it is clear that at the higher level, the operation of these dams is seen as a component in the management of the water resources of the whole Yangtse river basin. The Magat Dam was originally conceived as an element in a hydropower development plan for the Cagayan valley, but this was not implemented. The Nam Ngum 1 Dam is now seen as a component in the wider development of the water resources of the Nam Ngum 1 basin, but this was only conceived after its implementation as a stand-alone project.

The lack of a river basin planning mandate on the part of the implementing agency has proved to be most serious in the case of Magat. The life of the dam is being severely compromised by the effects of widespread and destructive colonisation of the watershed. NIA and NAPOCOR have only marginal responsibilities for erosion control around the edges of the reservoir. An attempt to secure a major foreign aid project to address the watershed issue in the mid-1980s failed, and the provision of revenue to local authorities for community forestry projects through the National Wealth Tax from a cess on electricity sales has been a case of too little, too late.

2.2. Options Assessment and Planning

2.2.1. Project Justification

A dam can provide many benefits: irrigation water, hydropower, flood control etc. The question is whether these benefits are needed. That need has to be established. Usually, the justification is made in terms of realisation of macroeconomic or sectoral development objectives such as industrialization needing power, poverty reduction requiring increased food security, etc. These objectives are usually contained in national development plans or policy statements.

The case studies provided different patterns of rationalisation. Lingjintan is justified by the energy needs in an area with an expected shortage of electric power. Magat was conceived as an effort to raise food sufficiency for the country, which was facing food shortages and needing to import foodstuff, and energy. Victoria was seen as a major element in river basin development. Nam Ngum 1 appeared to be the only way to meet the expected demand for energy for the country’s industrialisation drive. In all the cases except Lingjintan, the dam project was a step towards national development.
2.2.2. **General and Hydropower Planning**

From the perspective of electric power planning, the four projects share a few similarities but also have a number of differences. Although they provided multi-faceted benefits to varying degrees, the power benefits represented an important aspect of each project. In fact, power was the main benefit expected from Nam Ngum 1, Victoria and Lingjintan, and the secondary, but significant benefit expected from Magat. Table 2-1 sums up the different categories of benefits expected for each of the four projects.

**Table 2-1: Benefits Explicitly Planned for the Different Case Study Projects**

<table>
<thead>
<tr>
<th></th>
<th>Nam Ngum 1</th>
<th>Victoria</th>
<th>Magat</th>
<th>Lingjintan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power generation</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Irrigation</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Navigation</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Flood control</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Re-regulation</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Reduced GHG emissions</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Tourism</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Fisheries</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Recreation</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Municipal water supply</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Rural electrification</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>National development</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Regional, provincial development</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Development of the immediate area of the dam</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Electricity exports</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

Provision in the four projects for implementation in stages varied. Thus, it was initially planned (in the feasibility study of 1962) that Nam Ngum 1 would be commissioned with an installed capacity of 40 MW, to be increased up to 120 MW in subsequent years. The Nam Ngum1 Fund Agreement reduced the capacity to be initially installed to 30 MW. In 1980, an ultimate addition was planned to upgrade the capacity up to 150 MW.

A two-stage implementation plan was proposed by the preliminary feasibility study of Victoria; the first stage was to correspond to the commissioning of 210 MW, while the second stage would add 210 MW of installed capacity, bringing the total final capacity of the project to 420 MW. Only the first stage has been implemented to date. The feasibility study for Magat proposed a two-stage implementation; the first stage would implement 200 MW and the second stage was to implement 300 MW. Later, the engineering study for the project proposed increasing the first stage of Magat up to 360 MW, with provision only for a second and final stage to provide a total installed capacity of 540 MW. Finally, the Lingjintan hydropower project was to start with a 30 MW installed capacity, with seven more 30 MW units to be successively installed, thus providing the power plant with a total final capacity of 240 MW. In 1997, it was proposed to add a 30 MW unit to Lingjintan hydropower station was proposed in order to increase the total installed capacity of the scheme to 270 MW. How the four projects were actually implemented is shown in Table 2-2.
Table 2-2: Summary of Hydropower Implementation of Case Study Projects

<table>
<thead>
<tr>
<th></th>
<th>Nam Ngum</th>
<th>Victoria</th>
<th>Magat</th>
<th>Lingjintan</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Stage 1</strong></td>
<td>2x15 MW (1972)</td>
<td>3x70 MW</td>
<td>4x90 MW</td>
<td>9x30 MW</td>
</tr>
<tr>
<td><strong>Stage 2</strong></td>
<td>2x40 MW (1978)</td>
<td>3x70MW (provision only)</td>
<td>2x90 MW (provision only)</td>
<td></td>
</tr>
<tr>
<td><strong>Stage 3</strong></td>
<td>1x40 MW (1984)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Current installed capacity</strong></td>
<td>150 MW</td>
<td>210 MW</td>
<td>360 MW</td>
<td>270 MW</td>
</tr>
</tbody>
</table>

The first divergence that should be noted when comparing the respective planning processes of the projects studied relates to the accomplishment of a full feasibility study. One was carried out for Nam Ngum1, Magat and Lingjintan; but however, for Victoria, a ‘preliminary’ feasibility study, prepared in 1979, was the basis for deciding on the implementation of the project.

In the case of Nam Ngum1, Victoria and Magat, the expected power benefits were those strictly related to the power generation by the projects. On the other hand, the power benefits expected from Lingjintan included meeting the navigation requirement previously assigned to the upstream Wuqiangxi, thus enabling Wuqianxi to generate power more effectively to meet system load.

Moreover, not all of the projects used modern planning tools. No optimisation power system planning model contributed to appraisal of the feasibility of Nam Ngum1 and Magat. There is no mention of a planning model in the Nam Ngum1 feasibility report, and it is not shown to be part of a least-cost expansion plan. The Magat project was primarily planned for irrigation, therefore no electricity planning model comparing candidate power plants was applied. However, a partial planning model was used to simulate the future operation of Victoria, and an integrated energy-planning model was used during the feasibility study of Lingjintan. During the feasibility study of the Victoria project, the consultants developed their own model for analysing the future operation of the scheme. Later, a model for system expansion planning was applied by CEB. For the Lingjintan project, a model entitled IRELP was run by MSDI to ascertain that the project was part of the least-cost plan for the extension of the Hunan power system.

The comparison also showed that in some cases the planning process of a project failed to carry out an options assessment. Thus, the planning process of Victoria, based on the Preliminary Feasibility Study, did not carry out a comparison of the plant to other alternative power generation options. However, for Nam Ngum1, Magat and Lingjintan, the cost of the proposed hydropower plant was compared with that of an alternative thermal plant for expansion of the power generation systems respectively in the Lao PDR the Philippines and the People’s Republic of China. Yet, Nam Ngum1 only considered the financial costs involved in the alternative power plant, while Magat and Lingjintan considered the environmental and social impacts, even if only qualitatively. None of the projects envisaged possible upgrading of existing hydropower plants.

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1 Magat was only included in the PDP of Napocor in 1980, when construction had already underway 2 years.
In any case, Lingjintan stands out among the four projects for several reasons. First, only Lingjintan was clearly presented as part of a least-cost plan for the expansion of the power generation system in Hunan Province. Hunan Electric Power Corporation (HEPC), the central power utility for Hunan Province) directly participated in each stages of the project. Indeed, Lingjintan was part of the expansion programme of HEPC, which participated in most of the discussions during planning. The power utility was the implementing agency for the project, and through WHDC (Wu-Ling Hydropower Development Corporation), HEPC was further involved in the operation of the project. Last, the planning process of Lingjintan involved additional institutions specifically responsible for hydropower development, (the Planning and Design Institute for Water Conservancy and Hydroelectric Projects), which listed Lingjintan as a project subject to pre-construction study in 1989, and the Mid-South Design and Research Institute for Hydroelectric Projects, which prepared the EIA in 1991). In the case of Nam Ngum1, the Mekong Committee, and later its national representative in the Lao PDR, were involved in the planning process; however, the main concern of those institutions is the general development of the Mekong Basin, and hydropower is just a part of that interest. This is also true for the Mahaweli Development Board (MDB), which assisted the planning of the Victoria hydropower project. In the Philippines, the planning of the Magat hydropower project was mainly assigned to the National Irrigation Authority (NIA), an institution specialised in irrigation-related issues.

In addition, Lingjintan, and Nam Ngum1 did not consider the cost of the transmission line required for an alternative thermal plant in the options assessment (there was no options assessment at all in the case of Victoria). However, this task was carried out during the feasibility study for Magat. The electricity planning aspects of the four dams are summarised in Table 2-3.

**Table 2-3 : Electricity Planning Aspects of Case Study Projects**

<table>
<thead>
<tr>
<th>Existence of a full feasibility study</th>
<th>Nam Ngum1</th>
<th>Victoria</th>
<th>Magat</th>
<th>Lingjintan</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Use of a system planning model*</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Inclusion of environmental impacts in the selection of alternatives</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Involvement of the power utility</td>
<td>Operation</td>
<td>Operation</td>
<td>Construction and operation</td>
<td>Planning, construction, and operation</td>
</tr>
<tr>
<td>Options assessment carried out</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Consideration of the cost of the transmission line for the selection of alternatives</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Consideration of upgrading existing hydropower plants for the selection of alternatives</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

*In the case of Victoria, a partial system model was used to simulate the future operation of the scheme. Lingjintan, on the other hand, used a least cost-planning model.
2.2.3. Planning of Other Water Resource Uses

In addition to hydropower, other potential benefits from water resources development were identified in the planning stages of the four case study projects. These benefits included irrigation and agricultural development, flood control and impact alleviation, re-regulation of power plant releases, and navigation and downstream flow augmentation.

Not all the potential benefits were identified and assessed during the early stages of project development. However, some of the projects were planned several decades ago, and additional benefits not “predicted” during the earlier stages have been realised since their commissioning.

Irrigation and Agricultural Development

During the feasibility stage, benefits to be achieved from irrigation and agricultural development were identified in the case studies, except for the Lingjintan project. The Nam Ngum1 project was implemented essentially as a stand-alone hydropower project. Nevertheless, it was assumed that the dam would provide irrigation benefits in the Vientiane Plain through pump lift irrigation, using electricity from the hydropower plant. However, comprehensive development of irrigation in the Vientiane area was largely delayed until the early 1990s because of civil strife and a lack of donor support, with only isolated development of modern irrigation systems being carried out under the Mekong Committee. After 1981, these developments were based on the availability of electricity. During the past decade, there has been considerable investment through MRC and EU projects into the development of irrigation.

With respect to Victoria, it is difficult to attribute to the project the development of irrigated agriculture in the area downstream of the dam. Security problems prevented the opening of areas identified during the feasibility stage. The actual planted areas were rather less than the planned areas. Yields also proved to be less than those assumed in the feasibility study.

As for Magat, considerable benefits for both irrigation and agricultural development have been realised from the reservoir, as its primary purpose has been to serve the irrigation needs of the downstream agricultural areas.

Flood Alleviation

Except for the Victoria dam project, flood alleviation was considered as a benefit in the case study projects.

For the Nam Ngum1 project, it was planned to protect a large area of the downstream river basin from floods of frequent recurrence intervals. However, no assessment of actual benefits from flood protection was carried out. The national power utility operated the reservoir for the sole purpose of power production, although high floods were experienced. The impact of damage incurred downstream is not known. Today there is some evidence of benefit from flow regulation (both low-flow augmentation and flood control) of the Nam Ngum1 River.
In the Magat project feasibility study, flood control was considered to be an area of major concern. Inundation of low-lying areas along the river was a common occurrence. Three major floods were experienced between the time of the feasibility study and project commissioning. Flood control facilities constructed under the direction of the Bureau of Public Works proved to be effective until the occurrence of the extreme flood in October 1971.

The relatively small storage capacity of the Lingjintan project cannot affect flood control.

Re-Regulation

Only the Lingjintan project serves as a re-regulation scheme. Its implementation enables the upstream located Wuqúangxi project to run at full peaking power in serving the Nunan electricity grid, and to not have to run permanent baseload to satisfy the navigation requirements within the Yuanshui river development chain.

Navigation

The implementation of the Lingjintan project at operational level submerges upstream rapids, thus allowing for all-season flow in that part of the river cascade. In other case studies, benefits from river navigation have either been identified but no quantified (Nam Ngum1) or are not applicable.

Downstream Flow Augmentation

Only in the case of the Lingjintan project have downstream flow augmentation possibilities been identified; However, no benefits have been attributed to the project.

2.3. Engineering

2.3.1. Alternative Project Layouts

The feasibility study for the Nam Ngum I project (1962) considered three alternative dam sites within a radius of about 20 km, using “rough estimates” of construction costs and specific energy costs. Some qualitative consideration was given to the relative merits of the dam sites with regard to possible flood control benefits, but the study did not include any mention of expected socio-environmental impacts when comparing the sites.

For the Victoria project, two alternative sites were considered within a straight gorge of about 500 m in length, upstream of the Victoria Falls on the Mahaweli Ganga.

The original recommendation for the location of the Magat High Dam was a site 18 km upstream of the existing Magat Diversion Dam or 12 km upstream of the site finally chosen. However, the feasibility study (1973) determined that the dam at this upper site would have to be raised in order to attain a storage capacity adequate for silt retention as well as a useful life of 100 years. On that basis this alternative was compared to the eventually recommended site, and it was concluded that the costs and benefits of the two locations would be practically the same. However, the upper dam alternative of raising the water level at the upper site to provide space for sediment accumulation would have resulted in the flooding of the upstream
town of Bagabag and increase the affected population to 12,700. NIA had had negative experiences during the implementation of Pantabangan, which flooded a similar small urban area. In order to avoid the economic and social problems likely to be caused by the relocation of Bagabag, the lower site was finally selected.

For the Lingjintan project, five alternative dam sites were studied, all in the 4-km reach of the river between Hejiazui and Zhairougsi. The selection of the Zhairougsi site (the farthest downstream) was made on the basis of bedrock and channel conditions, which were particularly favourable to river diversion and dam construction. For the Lingjintan project, the potential layout of project features influenced the selection of the dam site, but it was also optimised for the selected site, with four alternative layouts studied. The layout varied principally in terms of the locations of the powerhouse, spillway and navigation lock. The selection was made on the basis of hydraulics, work quantities, lock operation, length of construction period, and overall cost. The environmental impacts of the various layouts was be essentially the same, since there would be no real differences in work area, materials, and area of inundation.

2.3.2. Field and Laboratory Investigations

Nam Ngum 1

The Nam Ngum 1 feasibility study was based on relatively limited topographical, geological and hydrological data, compared with today’s standards.

The detailed topographic and geological investigations, presumably to the standards normally required for definite design, were undertaken in 1996 and 1997. They allowed the construction cost of the project to be estimated with some degree of accuracy.

At the feasibility stage, the available information on expected project inflows was based on 14 months of measured flow at the dam site and three years of coincident flow data from a downstream hydrometric station. It was supplemented by several decades of precipitation data from climatological stations located in Vientiane and its environs. On the basis of recorded flows and computed reservoir inflows from 1959 to 1996, it can be concluded that the feasibility study estimate of 308 m$^3$/s has proved to be reasonably accurate (actual figure 302 m$^3$/s). Compared with the feasibility study estimate of an annual sediment accumulation of 0.65 million m$^3$, the actual sediment accumulation is three times higher. However, despite evidence of widespread deforestation in the drainage area, the sediment accumulation in the reservoir is not a critical issue.

Victoria

For the Victoria project, detailed topographic and geological field investigations, to the standards normally required for feasibility and later definite design, were undertaken in 1978 and 1979. Those investigations enabled the final configuration of the project to be established and the construction cost of the project to be estimated with some degree of accuracy.

However, the preliminary feasibility report of 1978 noted, the absence of regular topographic surveys at the gauging stations (in order to detect cross-sectional variations with time), the lack of discharge measurements at high flows, and the practice of simple logarithmic
extrapolation of rating curves to higher stages (thereby failing to take cross-sectional discontinuities into account). Furthermore, it was observed that missing periods of records had been reconstituted by unspecified correlation methods. However, due to the limited time made available for the hydrological studies, additional discharge measurements and subsequent re-processing of the original water-level records could not be undertaken. The data for Peradeniya, Gurudeniya, Randenigala and Talawakanda were therefore accepted as provided.

For the assessment of reservoir inflow, available data on seven years of measured flows at the Victoria dam site have been applied, supported by measurements taken over 30 years at nearby sites. The mean natural inflow to Victoria observed over the 15 years since the start of operation has been 84 m$^3$/s, about 20 per cent lower than the estimated mean flow of 105 m$^3$/s. An average sediment inflow of 0.93 million t/a has been estimated, implying a depletion of about 7 per cent of active storage over a 50-year period.

Magat

Prior to commencement of the engineering design for the Magat project, topographical maps of sufficient scale were prepared. Geological mapping and construction materials investigation were undertaken in sufficient depth and detail. Historical streamflow records of 35 stream gauging stations in the Cagayan river basin were used. A comparison of average annual inflows observed before and after implementation of the Magat project show that during the latter phase runoff had diminished by about 15 per cent. Inspection of rainfall data confirmed this decrease in water availability. A detailed river sediment sampling programme, including the potential delta formations near the upper end of the reservoir, and degradation studies were carried out.

The feasibility study of 1987 estimated an annual reservoir sedimentation rate of 6.1 million tons, leading to a decrease of 60 per cent in reservoir after 100 years of operation, which was confirmed during the engineering Design studies.

As is typical for the project development cycle, the amount and accuracy of field data continuously increased with the progress of planning and design. However, in the feasibility report for Lingjintan, detailed data tables or graphs were unavailable to a large extent and methodological approaches were presented in a rather sketchy way.

Information on topographic surveys and maps produced and used for the planning and design were unavailable.

Various geological explorations were undertaken at the proposed Lingjintan site between the planning and design stages of project development in order to determine the geological conditions within the reservoir and at the dam site. Sources of construction materials in sufficient quantity and quality were identified.

For inflow assessment, a time series of monthly reconstituted reservoir inflows over 38 years was applied. A detailed assessment of the retention potential of the Wuqiangxi reservoir, located upstream of Lingjintan and under construction during the planning stage of the latter, was also undertaken. According to the feasibility study, the river carries almost no sediment in the dry season and only a very small sediment concentration during the flood season.
Furthermore, the huge volume of the Wuqiangxi reservoir reduces the sediment freight to a negligible dimension. Long-term navigational use of the Lingjintan project is therefore not impeded.

2.3.3. Design

Dam Height and Type Selection

In the case of the Nam Ngum 1 project, the topographic and geological conditions prevailing at the selected dam site were suited to practically any dam type. The original design examined three different types: earthfill, rockfill and concrete gravity. Costs and other considerations (e.g., flood hydrology, ease of transport of construction materials, and availability of construction materials) were considered when making the final selection of a concrete gravity dam. Reservoir levels between 208 m a.s.l. and 228 m a.s.l. were investigated, with the final choice being to be at 212 m a.s.l.

The topographical and geological condition prevailing at the Victoria dam site were best suited to a concrete dam, either: arch or gravity-arch and arch. Together with a rockfill alternative, all types were investigated and it was found that practically any type was feasible. Arrangements for the spillway and river diversion during construction played a major role in determining the most appropriate and least-cost type of dam; a double curvature arch concrete dam was finally selected. Based on the analysis of costs and benefits (power and irrigation) of 15 possible reservoir full supply levels and installed power plant capacities, the final full supply level was selected.

During the Magat river project feasibility study, a rockfill section for the entire length of the dam was initially selected. In a subsequent design, however, a composite rockfill/concrete gravity dam was favoured. Due to the low quality of the foundation rock and aggravated by the known seismic activity in the area, alternative dam types including multiple arch, and earthfill dams were subsequently considered, leading to the final selection of a zoned earth and rockfill dam. No alternative reservoir levels were investigated.

In the case of the Lingjintan project, the feasibility study of 1988 planned an earthfill dam on the left river bank; however, following design optimisation, a concrete dam was found to be more economical. Details leading to the final selection were not available. The selection of the finally selected reservoir elevation was largely dictated by the need to submerge the upstream Wengzidong rapids to provide sufficient depth for river navigation. Therefore, only a small range of alternative levels were investigated. The inundation of homes and infrastructure played the deciding role in final selection.

Spillway Design :

In the Nam Ngum1 project, the spillway design flood was derived on the basis of extreme precipitation data observed at climatological stations in and around the Nam Ngum1 basin. The 1 in 1,000-year flood occurrence was adopted for an ungated spillway. During later studies, the newly estimated peak discharge of the PMF was reassessed, and the spillway was designed for that flood, but with four control gates installed.
In line with standard practice, the spillway capacity for the Victoria project was designed on the basis of the PMF. The project’s eight automatically controlled counterbalanced spillway gates are capable of passing this PMF flood with a tolerable surcharge.

Since the Magat dam impounds a large volume of water, and because overtopping or failure would cause personal injury and severe damage to property downstream, a high standard of safety was adopted in the selection of the reservoir inflow design flood. The estimates of peak discharge and flood volume were based on characteristics considered to approach the most severe “reasonably possible” at the given location. For determination of the spillway design capacity, a peak inflow of 34,500 m$^3$/s with a 10-day volume of 8,420 million m$^3$ was adopted. A gated open chute spillway with flip bucket was selected.

The Lingjintan project selected a gated flood sluice spillway with stilling basin. In line with the local design criteria SDS 1278, the spillway capacity was designed for a 1 in 100-year flood. Structural stability was verified by applying the 1 in 1,000 year flood criterion.

Miscellaneous Structures

The Nam Ngum1 project feasibility study of 1962 makes no mention about a fish ladder or the need for a re-regulation pond.

For the Victoria project, low-level outlets with a defined capacity were provided to allow the provision of irrigation water at times when the power tunnel is closed for maintenance. In addition, these outlets act as silt scour sluices to enable the downstream river bed between the dam and powerhouse to be periodically flushed. A re-regulation pond was not foreseen since the reservoir of the downstream Randenigala scheme acts as the tailwater for the power discharges from the Victoria power station. A fish pass was not considered.

For the Magat project, the Maris and Baligatan diversion dams act as re-regulation ponds. There is no indication whether a fish pass was considered.

The selection of the type and size of the structure to allow vessels to pass the Lingjintan dam was based on the height of the dam, river conditions at the site and the characteristics of the cargo fleets operating on the river. As an alternative to the selected lock, a water-wedge ship lift was also studied but was found later to offer lower efficiency.

2.3.4. Overall Assessment of Procedures for the Design Process

The engineering design work for three of the case study projects was undertaken by the international consulting firms. The fourth project, Lingjintan, was developed by a major national water resources project design institute. As would be expected, therefore, the studies were generally carried out to the highest internationally accepted standards. For example, in the case of the Victoria project, a World Bank sector review commented that “… design and

construction standards are according to best practice ..."). No major technical problems as a result of the engineering design processes applied have arisen at any of the projects.

From a present-day perspective, it could be noted that use of current design practices would possibly have resulted in some additional alternatives being investigated (e.g., roller-compacted concrete dams, multi-level intakes etc.) In addition, experience gained in the past 10 to 20 years in the treatment of major technical problems in dams, such as alkali-aggregate reactions in mass concrete, would also now be brought into consideration in the design process.

2.4. Financial and Economic Appraisal

Once the need has been identified, different alternatives to meet that need must be considered and evaluated based on a common set of criteria or, in terms of technical feasibility, economic feasibility, financial feasibility and social acceptability. The environmental impact must also be assessed and evaluated in economic terms for inclusion in the financial and economic analyses.

The case studies show different practices in financial and economic appraisal. In the case of Lingjintan, as the latest to be built, a more up-to-date approach to analysis was employed. The analysis used a cost-benefit approach as required by the ADB, the funding agency for the project. Cost-benefit analysis was also used for Magat and Victoria.

A cost-benefit analysis identifies benefits and costs. Dealing with capital costs is straightforward, while other costs, more social and environmental in nature, have proved more difficult. Social costs, particularly those of resettlement of the affected population, have tended to be underestimated. Restoration of livelihood has not been achieved in all cases for a significant period after the dams have been brought into operation. Magat is an example where the resettled population has been forced to change its way of life, from that of a forest-dwelling, hunting and gathering lifestyle, to that of settled mono-cropping farmers with all needs being met from cash income. Environmental costs tend to be ignore; in the case studies, these costs have not been explicitly taken into account. However to be fair, they have not been large, unlike in the case of some dams elsewhere. The main environmental cost has been the loss of forest, which in these cases appears not to have been especially noteworthy.

The identification of benefits for the case studies followed traditional approaches. Dams are seen to provide a range of benefits such as hydropower, irrigation, and flood control, and in the case of Lingjintan, the navigational benefit. Not all these benefits have been quantified.

The hydropower benefit was the most clearly to be identified. In all four cases, it was identified as a major component of the project, meeting national and sectoral goals. In the case of Lingjintan, the benefit extends the system effect of improved operation of the upstream dam at Wuquiangxi.

The irrigation benefit is seen to be significant in the case of Magat, and less so in the case of Nam Ngum1, where the terrain does not permit a low-cost gravity type of distribution system. In the case of Victoria, it was doubtful even at the planning stage whether irrigation could be counted as a benefit of the project. Different studies attributed the irrigation benefits to
different areas, but none were developed. Lingjintan, being a run-of-the-river dam, was not seen to provide any irrigation benefit.

The valuation of project costs and benefits has followed the standard practices of shadow pricing, using conversion factors to transform market prices to economic prices. In the case of Nam Ngum1, the appraisal was made in financial terms only.

The distinction between financial and economic analyses was not strictly observed. All four case studies were government projects, and there was little incentive to achieve cost recovery, since the finance was provided by foreign grants - (Nam Ngum1 and Victoria) or loans on concessionary rates of return on appraisal, Nam Ngum1 showed the lowest rate of return at just 3-4 per cent. This was justified as an infrastructure project. The others gave rates of return on appraisal of more than 10 per cent, which is acceptable by today’s standards.

2.5. Social Impact Assessment

The resettlement issues in the four case study projects differed considerably in scale and characteristics. The largest settlement programme by far was at the Victoria Dam, where over 30,000 people were displaced. Settlement was divided into two main areas: around the reservoir itself in the suburbs of Kandy; and in the downstream System C irrigation area, even though it was not specifically planned for Victoria settlers. Other settlement programmes were smaller. Nam Ngum1 displaced 579 families, although the precise numbers and the settlement process were confused because of the effects of civil strife. Households affected by the Magat Dam totalled 431, including 121 “second priority” households comprising newly formed families who were not given land in the resettlement area. This was the only case in which minority groups, the Ifugao, were directly affected by resettlement. In all three cases, at least some of the resettlers were accommodated in the irrigation areas downstream, although at Nam Ngum1 the process of irrigation development took place in a separate project that only began five years after the dam closure.

The resettlement programme at Lingjintan may be more correctly termed “relocation” since it mainly involved the upslope movement of families from the reservoir to the redistributed and newly developed land nearby, mainly in the same commune. A total of 4,700 people (830 households) were affected. The livelihood options that were developed were much more varied than in the other three schemes

2.5.1. Policy Framework

In none of the three earlier case studies (Nam Ngum1, Magat and Victoria) was there any national policy framework for dealing with resettlement from large water resource development projects. This is scarcely surprising in the case of the Lao PDR, where Nam Ngum1 was the first such development; however, in the Philippines several large dams had been developed prior to Magat and lessons had been learnt from them, particularly in the case of the National Irrigation Administration at Pantabangan. However, responsibility for such projects was divided between NIA and NAPOCOR according to the main project objective, and no overall guidelines were thus developed. In Sri Lanka, the Mahaweli Authority used the norms established in relation to settlement in general, but not for resettlement from large water resource development projects in particular.
In contrast, problems in large-scale water resource development projects in the People’s Republic of China in the 1960s and 1970s had forced the government into developing extensive guidelines and regulations for what is still a major development programme on a national scale. They have become more stringent over time, and the case of Lingjintan reflects those guidelines.

Such guidelines have been developed in the Philippines through Executive Order No.1035 of 1985, on Acquisition of Private Real Properties. The guidelines have been incorporated into a policy framework for the improvement and repair of national irrigation systems Component of the Water Resources Development Project. Funded by the World Bank, that project follows the principles of World Bank Operational Directive 4.30. In the Lao PDR, again under World Bank guidance, a draft National Resettlement Policy was prepared in 1998 and appears to be influencing the planning process at several new large-scale water resource development projects, notably Nam Theum 2.

2.5.2. Planning Process

The planning and construction of the four case study dams included in this Study covers a period of more than 30 years, from the time of the feasibility study of the Nam Ngum Dam1 in the mid-1960s to the Lingjintan dam which was still under construction in 2000. The degree to which social issues were incorporated in the planning and design naturally reflected the prevailing norms in large dam development at the time, both in terms of the sophistication of coverage of social and resettlement issues, and public participation.

At the feasibility study level, the spectrum ranges from almost total silence on social impact issues in the case of Nam Ngum1, through extensive reviews of social issues, and comprehensive physical planning for settlements in the Victoria Dam and System C preliminary feasibility studies (PFS), to mandatory inclusion of a settlement plan in the feasibility study in the Chinese case. Consideration of social issues in the options assessment at the detailed design stage was made in the case of both Magat and Lingjintan, although in the latter case the assessment was limited to a narrow range of dam heights. All cases made provision for, and carried out, surveys of household economies and living conditions of Project Affected Persons; however, only in the case of Lingjintan was raising living standards above the previous level an explicit goal. Restoration of livelihood in the other three cases was seen mainly in terms of offering compensation payments and access to alternative land. Nam Ngum1, it was unclear whether compensation payments were included in the Project Development Fund.
Table 2-4 : Consideration of Social Impacts in Planning the Case Study Dams

<table>
<thead>
<tr>
<th>Dam/Issue</th>
<th>Survey</th>
<th>Land compensation</th>
<th>Other assets Compensation</th>
<th>Inclusion in FS</th>
<th>Resettlement plan</th>
<th>Livelihood Improvement goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nam Ngum1 (1964)*</td>
<td>Post-FS</td>
<td>General site provision only</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Magat (1973-75)</td>
<td>Pre-FS</td>
<td>Yes, but payment by PAPs</td>
<td>Yes, fairly comprehensive</td>
<td>Yes</td>
<td>Yes</td>
<td>Restoration</td>
</tr>
<tr>
<td>Victoria (1978-79)</td>
<td>Post-FS</td>
<td>Yes</td>
<td>Yes, but omitted tree crops</td>
<td>Yes</td>
<td>Yes</td>
<td>Restoration</td>
</tr>
<tr>
<td>Lingjintan (1988-90)</td>
<td>Part of FS</td>
<td>Yes, through local redistribution</td>
<td>Yes, except for fisheries</td>
<td>Yes</td>
<td>Yes (Mandatory)</td>
<td>Improvement explicit</td>
</tr>
</tbody>
</table>

*Date of feasibility study

In general the local population heard about the development of the dams when the development agencies began survey work. Lack of prior notice of the purpose of the activity inevitably led to rumours and misinformation. The local population was not consulted on the decision to proceed with the dam, nor upon the design options. In the case of Lingjintan, consultation began only during the feasibility study stage, and even then it was limited to enlisting local authorities in assisting with data collection on the local social and economic situation. Typically, as was found in the broader review of WCD, participation of affected persons took place late in the overall process. In the case of the Victoria Dam, the local population was only fully informed after construction had begun, and in the context of more detailed surveys to determine the number of PAPs and the compensation payments allowed. In the other two cases, consultations began after the feasibility study was completed and was largely confined to discussion on compensation and choice of settlement site. Apart from calculation of compensation, people’s involvement was typically through village or local government leaders.

2.5.3. Implementation

With the exception of Nam Ngum1, where civil strife disrupted the process, the physical process of relocation/resettlement was carried out efficiently by the settlement authorities. Because of the large numbers involved and the telescoping of the whole development process, it was more hurried at Victoria, where some abuse was reported. At Magat, the settlement authorities showed sensitivity to the particular needs of the Ifugao ethnic minority.

However, a common problem at both Magat and Victoria was the inadequate preparation of the resettlement site prior to the arrival of the settlers. In both cases, most settlers were unable to obtain an irrigated rice crop until at least two years after arrival. Naturally that affected their ability to restore livelihood in the short term, despite efforts made by the settlement authorities to offer wage employment in compensation. In the case of Victoria, the limited land clearance in System C and the inadequate drainage conditions led to a major outbreak of malaria, to which the resettlers, coming from an upland environment, had little resistance. A similar problem currently exists at Lingjintan, where the development agencies have been slow to clear land for tree crops.
With the exception of the irrigation system, the physical facilities for settlement were well planned and complete at the time of settlement. In the case of Lingjintan, a flexible policy on housing compensation has given settlers the opportunity to improve their housing standards. However, it has not always proved possible to provide the human resources necessary for staffing the public facilities.

### 2.6. **Environmental Assessment**

The benchmarking of environmental conditions (in terms of baseline environmental surveys) was prior to implementation for both the Lingjintan and the Magat projects. For the Nam Ngum1 and Victoria projects, only water quality and significant ecological resources were baselined for EIA purposes. It was noted that there was considerable variation in emphasis on what environmental parameters should be baselined, basically due to the peculiarity of what the EIA regulations and guidelines had prescribed for each country.

For the Magat and Victoria projects, the environmental impacts were assessed for the various project planning study stages. However, it should be added that for the Victoria project, there was no reference to the EIA process or the consideration of environmental resources during the project development process. Rather, it is probable that the EIA study was undertaken to justify the execution of the project, with the EIA study therefore not serving as an evaluative project planning tool. For the Lingjintan project, an EIA study was conducted; however the focus was more on air and water quality impacts, the negative effects of which became the target of specific mitigation measures. The EIA failed to address more significant adverse ecosystem impacts (such as migratory fisheries losses as well as riparian impacts) that were serious enough to have warranted the environmental monitoring of those impacts. In the case of the Nam Ngum1 project, an EIA study was never undertaken. None of the four case studies were subjected to a specific, sector-wide EIA pertaining to the pursuit of hydroelectric power projects as an integral component of the country’s energy sector programme.

With the exception of the Lingjintan project, the other three case studies failed to anticipate the occurrence of significant adverse impacts on migratory fish and other aquatic communities, or the negative impacts on reservoir water quality.

During the project planning and development process, the environmental mitigation plan aspects (notwithstanding the recommendation of specific mitigation measures) and the environmental enhancement action plans were not addressed in the EIA-related studies of the Lingjintan, Magat and the Victoria projects. In the case of Nam Ngum1 project, these aspects were not tackled since no EIA study had been undertaken for the project. The Magat, Nam Ngum1 and Victoria projects have nonetheless incorporated environmental management programmes oriented towards sustainable management of watershed conditions.

Although water quality and public health monitoring were recommended for the Lingjintan project, and a broader environmental monitoring programme (with sediment inflows being monitored recently) was propounded for the Magat project, no environmental monitoring programme was recommended for either the Nam Ngum1 or the Victoria project.
2.7. Project Implementation

Nam Ngum1

Government authorities consider the Nam Ngum1 dam to be a highly effective development project, offering a wide range of benefits to the country. It was the first large-scale development project in the country and its completion during a period of civil strife was seen as a significant achievement and a source of national pride. Although there was fighting around the dam site, the future Pathet Laos, who were to form the future government, were fully committed to the project, which was seen as a valuable resource for the whole country. Visitors to the dam site have often commented on the exemplary management of the facility, although some of the intended benefits have come onstream significantly behind schedule. This is particularly the case with the expected irrigation benefits. However, this failure must be seen in the context of the political isolation of the Lao PDR from 1975 to 1987, which limited the amount of foreign aid received as well as the government’s own revenue resources. It can be argued that the period was a gap in the development of the Nam Ngum1 multi-purpose projects and not only now is further investment being made in the infrastructure, which will facilitate the achievement of the intended benefits. Fortunately for the country, significant “unexpected” benefits have, in the meantime, been derived from the development of the reservoir fisheries.

The “Comprehensive Project Feasibility Report on the Nam Ngum 1 Project”, issued in 1962, envisaged that benefits from the project would accrue in four principal areas: power production, flood control, irrigation and navigation. A later report by the Mekong Secretariat ascribed two further potential benefits to the Nam Ngum 1 project: fisheries and downstream low-flow augmentation (for any future downstream hydropower and/or irrigation schemes on the mainstream Mekong River). In the later part of the 1990s, the Nam Ngum 1 reservoir was projected to become a site of major development for tourism/recreation.

It was originally planned that benefits from power production would gradually build up over 25 years to reach a supply of 738 GWh per annum, approximately 90 per cent of which would serve general industrial and pumped irrigation demand in the Lao PDR. The remainder would be exported to Thailand, including a total of 260 GWh to be provided from 1975 to 1982 for the construction of the Pa Mong project on the main Mekong River.

A three-stage buildup was achieved over the first 12 years to an average annual supply of 811 GWh over the 16-year period from 1979 to 1995. In 1996, the upgrading of the existing turbine generator units 1 and 2 brought an unexpected increase in power production of about 20 per cent or 160 GWh per annum. Actual power supplies to the Lao PDR turned out to be around only one half of those projected; the proportion of supplies exported to Thailand therefore accounted for some 80 per cent in the initial years, decreasing to around 65 per cent in the mid-1990s.

The predicted demand for electricity from the development of heavy industry in the Mekong basin did not materialise.
Although approximately 10,000 ha of the downstream Nam Ngum 1 basin were expected to be protected from floods of magnitudes up to 1 in 100 year, no assessment of actual benefits from flood protection was carried out. The Nam Ngum1 project is operated by the national power utility, EdL, expressly for the purpose of power production, with reservoir operating policies designed to meet demand for electricity supplies to demands from the northern Lao PDR power grid, and to maximise expected revenues from the export of surplus power to Thailand. It is known that, during the high floods experienced in the lower Nam Ngum1 basin in August/September 1995, the Nam Ngum 1 reservoir effected a 20 per cent attenuation of the flood peak at the project site. However, the impact incurred downstream is not known.

Nevertheless, there is some evidence of benefits from the regulation of flow (both low-flow augmentation and flood control) of the Nam Ngum 1 river, particularly in the lowest areas of the Vientiane plain.

Provision of pumped irrigation to the Vientiane plain was projected to be implemented immediately after dam construction. However, this only occurred after the implementation of the ADB-funded projects “Vientiane Plain Rural Electrification I and II” from 1981 onwards; the actual development of the irrigation systems in the Vientiane plain is ongoing. A total of 21 separate systems have now been developed, utilising pumping from the Nam Ngum 1 in Vientiane province and Vientiane municipality. Some of the systems have been built by the government, while others have been constructed through foreign-aid projects, first by the Mekong River Commission in Pak Cheng and including the European Union and JICA.

Information about river navigation is not available, and no specific benefits have been attributed to low-flow augmentation on the mainstream Mekong River.

During the planning stages, the project costs were underestimated in comparison with the final costs. Social and environmental costs were not considered.

Victoria

In general, the planning and design of the Victoria project appear to have been carried out in compliance with those criteria and guidelines of the day that were related to water resources planning and project design. It is probable that the government decision to accelerate the Mahaweli Development Programme led to time spent on studies being severely restricted. More time should perhaps have been allowed for a more thorough assessment of the hydrological aspects, and for a better understanding of the riverbasin and power system implications.

The purpose of the Victoria project and the broader hydropower development in Sri Lanka was to meet an expected growth in electricity demand. The implementation of a large generation scheme was consistent with that purpose.
The “Preliminary Feasibility Report”\(^3\) and the “Report on Additional Work to Complete Phase I Studies”\(^4\) envisaged that benefits from the project would be power benefits.

At the time of appraisal, the government’s objective was to supply electricity to a large part of the population in Sri Lanka. Increases in the rural electrification rate (from 16 per cent in 1986 to around 50 per cent at present) suggest that hydropower schemes implemented during the past years (including Victoria) complied with that goal.

During the planning period, the project did not pay much attention to the environmental and social negative impacts that could result from its implementation. In particular the flooding impacts were under-evaluated. Otherwise, the problems related to these matters could have been anticipated and managed more appropriately.

In spite of the simplifying assumptions made to determine how Victoria would operate, the economic analysis and the estimation of costs were judged by an ODA post-evaluation study to have been accurate with the exception of “flooding” (essentially resettlement) costs.

The projected average annual energy production was 970 GWh (first stage of 3 x 70 MW installed capacity). Benefits to downstream power plants through regulation were expected.

In comparison, the actual average energy production over the 15-year period since the start of operation in 1985 to the present has amounted to 672 GWh. The differences from the projected figure are due to:

(a) the actual natural flows being some 20 per cent lower than predicted; and

(b) the diversion at upstream Polgolla being around 50 per cent higher than assumed, partly due the regulating capability of the upstream Kotmale project and the perceived greater benefits for the river basin scheme as a whole. However, no specific assessment has been made of the gains actually achieved in comparison with the loss in hydropower output at Victoria.

Flood control benefits were not projected, and no assessment of actual benefits from flood control was carried out.

The preliminary feasibility study considered the Victoria dam project to be a hydropower project, and power was taken as the primary benefit. However, as a component of the wider Accelerated Mahaweli Programme, other benefits were foreseen, particularly the creation of employment through the downstream agricultural development programme. According to the Preliminary Feasibility Study, the Victoria dam was to provide irrigation water only to one system. The NEDECO Implementation Strategy Study argued that the Victoria dam could also be justified on power benefits alone and it linked it to the provision of the downstream irrigation systems (Systems A, B and C).

\(^3\) Hunting Technical Services et al, 1918.

\(^4\) Hunting Technical Services et al, 1918.
In fact, both the original and additional areas on the right bank have not been developed because of political unrest in the Eastern province. Thus, the benefits of the Victoria dam for irrigation can only be based on its role in the downstream part of the cascade of dams, which includes Randenigala, Rantembe and Maduru Oya, in so far as this serves an area on the left bank.

**Magat**

The potential of the Magat project for hydropower generation was estimated as 540 MW. However, the first feasibility study carried out in 1973, as well as the final feasibility study, of 1975, proposed a development with a reduced capacity.

The first feasibility study proposed the development of the project in two stages: the implementation of four units of 50 MW each by 1984, followed by two additional 50 MW units one year later.

The 1976 engineering study proposed an increase of unit capacity (90 MW instead of 50 MW per unit) and proposed the installation of a total of 270 MW. Finally, in the early 1980s, the installed capacity was increased to 540 MW (see the 1980 power development plan of NAPOCOR). The generation from the 360 MW was expected to be around 980 GWh per year.

However, the full potential of the Magat River (540 MW) has not been developed, possibly because it was deemed uneconomical. Therefore, the current capacity of the scheme is only 360 MW. Since implementation the average annual generation, has been 1,000 GWh, which is a little higher than the 980 GWh planned. A striking reduction in generation was observed in 1987 (possibly due to important political changes in the country) and, to a larger extent, between 1991 and 1993 (due to an El Niño related drought). These failures were, however, quite isolated and in general the dam met the objectives assigned in accordance with the current installed capacity.

Originally, an area of about 105,000 ha was expected to be irrigated by the Magat project. In 1985, however, only 69,100 ha in the wet season and 67,200 ha in the dry season were under crops. The reasons for the shortfall were the lack of on-farm facilities, lack of funds, difficult topography and deterioration of some facilities.

The appraisal of the whole Magat project, including the associated irrigation areas, envisaged a two-stage continuous implementation over about 13 years from the detailed engineering and pre-construction activities. The dam itself was constructed in nine years, with a time overrun of some 44 per cent.

The listed main factors which affected a timely completion of the various stages of development are:

- Natural calamities, such as typhoons and severe flooding, which caused extensive damage that required repair work to facilities

- The need to deliver irrigation water for dry-season crops as scheduled, adversely affecting the rehabilitation and upgrading of some areas
- Adverse weather conditions, making various project areas unworkable and inaccessible
- Delays in resettlement and payment of claims from landowners and the resettled population
- Poor performance by some contractors
- Delays in bidding out or awarding of some civil works and supply contracts;
- Delays associated with the takeover and/or cancellation of civil works contracts defaulting held by defaulting contractors
- Occasional shortages of some basic construction materials

On appraisal, the project costs were estimated to be US$ 560 million, of which about 45 per cent would be in foreign exchange. On completion, the actual total cost amounted to US$ 578 million, which was equivalent to an overrun of only about 3 per cent.

**Lingjintan**

The Lingjintan project was designed for re-regulation of releases from the upstream Wuqiangxi plant. Thus, the implementation of the Lingjintan dam would enable Wuqiangxi to play its full role as a peaking plant in the Hunan electricity grid. With the Lingjintan project development, Wuqiangxi would not have to maintain a permanent base load of 150 MW to satisfy downstream navigation needs.

According to the statements made during the planning stage, by year 2000 the Lingjintan Power Project would provide the Hunan electricity grid with an additional installed capacity of 240 MW and an additional annual power generation of around 1,135 GWh of peak and base load energy.

From the environmental perspective, the Lingjintan plant was also expected to avoid the addition of thermal generation in the Hunan grid, which have required an additional investment in pollution control.

Some benefits were also expected regarding navigation, tourism and fisheries.

In 1999, due to a fault in unit 1, the generation at Lingjintan was only 140.6 GWh. The expected output for the same year should have been around 650 GWh (as estimated by the revised feasibility study from 1994). Thus, the actual project generation was low compared with expected output.
2.8.  Project Operation

2.8.1.  Dam and Reservoir

Nam Ngum 1

In the 1962 feasibility study for the Nam Ngum 1 project, the selection of the most appropriate scale of development, represented by dam height (or, more precisely, normal maximum operating level), was made by estimating the specific energy production costs for a normal maximum operating level of 20 m, with the installed capacity correspondingly adjusted so as to yield approximately the same plant factor for all levels.

During the feasibility stage, potential benefits were expected to be obtained from irrigation, flood control, river navigation and flood alleviation. However, since commissioning, the project has essentially been operated for power generation. The project was intended to supply electricity to EdL’s Vientiane grid, with surplus production in the wet season being exported to Thailand at a periodically re-negotiated tariff, initially with a flat rate tariff and, (since 1991), a variable time-of-day tariff distinguishing between peak, middle and low load periods.

The project was implemented as a stand-alone hydropower project. However, the provision of irrigation benefits in the Vientiane plain through lift irrigation using electricity from the hydropower plant, was also considered. The development of irrigation was largely delayed because of civil strife and a lack of donor support up until the early 1990s. Thereafter there considerable investment has been made through Mekong River Commission and European Union projects.

The dam was built to its full height in stage 1, with only the spillway gates being installed at stage 2. The dam should, therefore, have been able to absorb floods more efficiently at stage 1 than at stage 2. However, no specific assessment of the increased flood control capability has been made. Any benefits from flood alleviation and river navigation have not been quantified.

The estimated annual soil loss and mean sediment yield in the Nam Ngum 1 catchment and its 13 tributaries and subcatchments is relatively low at 2.5 t/ha. This is attributed to low population density, the absence of settlements in 40 percent of the watershed, and the significant re-growth of forest and other cover in the unpopulated areas over the past two decades. The amount of sediment suspended in the streamflow increases in the monsoon season and decreases in the dry season. The actual solid load is estimated to be 65 0,000 on average. As the dead storage volume of the reservoir is about 34 million m$^3$, it is unlikely that the function of the reservoir will be impaired by silting within a reasonable project lifetime. Bathymetric surveying and core sampling carried out 20 years after operation (1971, first stage) showed an actual sediment accumulation of about 2.1 million m$^3$. Even on the basis of the feasibility study estimate of an average annual deposition of 65 0,000 of sediment, it would take more than 1,000 years to fill the reservoir storage below the present mean water level. However, downstream villages have complained about downstream bank erosion in some areas in recent years and they suspect that the water resource development projects are the cause.
Victoria

During the planning phase of the Victoria project, 94 per cent of project benefits were expected from power generation and the remainder from irrigation. Benefits from flood control and navigation were not considered. Thereafter, it was found that the storage of water at Victoria would allow the irrigation of much larger areas downstream of the project.

The Victoria project is operated jointly by MASL and CEB. MASL is responsible for the operation and maintenance of the dam, spillway, low-level outlet, control and observation buildings, and the reservoir, while CEB is responsible for operation and maintenance of the power tunnel intake, tunnel, surge shaft, powerhouse and switchyard. A complete set of operation and maintenance (O&M) manuals for all equipment and structures under its control, based on manuals provided by suppliers and contractors, has been completed. Computer-based O&M schedules have also been prepared. A database is maintained on operational performance (impoundment water levels, and releases), meteorological records (precipitation, wind speed, humidity, temperature and evaporation) and water quality (physical, chemical and biological parameters) at the major reservoirs.

Monitoring instrumentation (survey stations, pendulums, strain gauges, piezometers etc.) has been installed at the Victoria dam and other main structures. Weekly and monthly reports are issued. Although Sri Lanka is not located within a zone that is particularly earthquake-prone, the existing monitoring system has been supplemented with seismological instrumentation.

Significant forced outages of all three turbine-generator units were experienced in the initial years of operation, caused by design faults notably relating to the generator thrust-bearing vapour seals and the current voltage transformers – as well as improper maintenance. Problems were also encountered with clogging of the cooling-water intake filters and excessive vibration of the draft tubes. The latter problem precluded operation of the turbines at outputs of less than about 50 MW per unit. The international case study team was given to understand that some of the problems had persisted to some degree.

It is understood that a major safety review of the project is planned for the year 2000.

Management of the Mahaweli Ganga project is under the overall direction of the inter-agency Water Management Panel (WMP), which comprises representatives from MASL, CEB and various other national ministries and regional/municipal departments. WMP currently uses a reservoir operation simulation computer program for establishing seasonal operating plans, and for investigating operational policy options of the Mahaweli river basin.

CEB provides information on hydropower units available for servicing and their maintenance schedules, available thermal generating capacity, and projected peak system demands and load factors for each month of the season.

The simulation program is used to produce the “Seasonal Operating Plan” (SOP), showing tables of the expected average and 80 per cent reliable water supplies to the individual irrigation areas for each month of the season.
The annual average sediment inflow into the Victoria reservoir has been estimated at 930,000 tons. That implies a depletion of only about 7 per cent of active storage volume over a period of 50 years, a bathymetrical survey carried out in 1993 (five years after the commissioning of the project) confirmed the yield estimate. Sediment deposition in the Victoria reservoir remains within acceptable limits, probably as a result of the relatively limited reduction in forest cover in the upstream catchment area.

**Magat**

The Magat power plant was designed as a peaking load plant and has since supplied power to the Luzon power system grid. The availability rating of the plant has been good, registering above 90 per cent, except during the drought in 1992-1993. This level is higher than those for the Ambuklao and Binga hydropower plants operated by NAPOCOR in the Luzon grid.

The relatively high forced outage rate (> 2.0 per cent) encountered by the power plant during the early stages of operation was mainly due to mechanical problems with some minor components of the plant (e.g., excitation transformer and cooling system). The problems were eventually solved by making modifications in the design of the components. In addition, the Production Enhancement Programme, initiated by NAPOCOR in 1996, has significantly reduced the forced outage rates, thereby improving the system performance of the plant as well as the total system reliability of the Luzon grid. The improved performance has made Magat one of the high priority peaking load plants of NAPOCOR.

During the dry season, the plant operates in peaking mode. With a highly variable output that ranges from the maximum available capacity to complete shutdowns. During the rest of the year, Magat operates as a base load plant.

NAPOCOR and NIA have agreed that in the periods when the reservoir level is higher than the rule curve, NAPOCOR can utilise the water for power generation without restrictions. However, when the water level is lower than the rule curve, the volume of water that can be used for power generation is limited by the volume of water needed for irrigation. During emergencies, NAPOCOR can utilise additional water, but has to pay NIA an agreed fee per kWh generated.

Thus, the irrigation requirements limit Magat’s power generation. This is understandable as the project was conceived and designed primarily to provide irrigation benefits.

The estimates of the feasibility study with respect to sediment inflows into the Magat reservoir have been largely underestimated. The actual sedimentation deposition has resulted in a significant shortening of the estimated life-span of the project to only 47 years instead of the original 100-year estimate. This discrepancy in estimated annual yield of sediment from the Magat watershed basically stems from the accelerated deforestation and the subsequent degradation of the watershed area, a heavy earthquake in 1990 and the impact of strong typhoons that commonly occur in the region. The watershed is under extreme pressure from uncontrolled forest fires, illegal logging, grazing, shifting cultivation and other damaging land management practices.
The 1990 earthquake triggered massive landslides in the upper reaches of the watershed, causing heavy sedimentation in the main tributaries of the Magat River. Sediment encroachment into the live storage area is already affects power generation and, possibly, also irrigation water delivery. Sediments in the life storage are transported towards the dead storage when the reservoir is operated during low water levels. Between 1984 and 1999, the reservoir was operated for some 45 per cent of time below the designed operation rule curve. The actual sediment inflows and trapping in the dead storage greatly deviate from the feasibility study results and, therefore, have reduced the estimated operational life of the Magat project to 47 years.

**Lingjintan**

The normal maximum reservoir level of the Lingjintan project is largely dictated by the need to submerge the Wengzidong rapids in order to provide sufficient depth for navigation during all flow conditions.

The project is designed for run-of-the-river operation with daily pondage. Its annual operating duty is given as some 5,000 hours, which – given the installed capacity of 270 MW and an expected average annual energy of 1,215 GWh – is equivalent to a plant factor of 51 per cent, the same as that for Wuqiangxi.

Since the project was only recently completed, with the installation of the turbines still ongoing, little operational information is available.

So far only five of the nine turbo-generator sets have been installed. The “oldest” unit had been in operation for only 16 months. Information gathered during the field visit, however, revealed that turbine operation at low hydraulic head posed a problem: although the minimum hydraulic design head for Lingjintan is 2.2 m, the turbines generate high noise levels when operated below about 3.0 m.

Compared with Wuqiangxi, Lingjintan’s regulating storage capacity is only about 2 per cent. Therefore, Lingjintan’s flood operation is tightly linked to upstream events: whenever Wuqiangxi releases flood water, Lingjintan’s flood relief discharge will largely be equal to the inflow plus the concurrent flood from the intervening drainage area.

He current status of the project means that no detailed information about the effectiveness of the reservoir operation is available.

During the dry season, no sediment enters the Lingjintan reservoir, and only a very small amount is deposited during the flood season. The Lingjintan reservoir benefits from the low sedimentation yield of the Yuanshui catchment and the huge reservoir capacity of the upstream Wuqiangxi plant.
2.8.2. **Hydropower**

Nam Ngum 1, Magat, and Lingjintan were planned to (and actually) operate during both the off-peak and peak periods; however, similar information was not available for Victoria. At the time of its first and second stage, planning the operation of Nam Ngum 1 operation was initially aimed at meeting the national demand. Moreover, it appears that at the third stage, the main constraint was the maximization of the power benefits in order to earn hard currency income reasons. In fact, the current leading criterion for operating the power plant actually is the maximisation of power benefits. Magat and Victoria, on the other hand, were planned to and currently operate to meet the irrigation requirements (although in the case of Victoria, the benefits were mainly expected from power generation.). Consistent with the project plan, releases of water made to comply with the navigation requirement represent the main constraint to power generation by the Lingjintan hydropower plant.
### Table 2-5: Planned and Actual Benefits of the Case Study Projects

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Nam Ngum 1</th>
<th>Victoria</th>
<th>Magat</th>
<th>Lingjintan</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Planned</td>
<td>Actual</td>
<td>Planned</td>
<td>Actual</td>
</tr>
<tr>
<td>Power generation</td>
<td>Principal purpose</td>
<td>Target exceeded</td>
<td>Principal purpose</td>
<td>Power per year 60% of planned</td>
</tr>
<tr>
<td>Irrigation</td>
<td>Included in planning</td>
<td>Not effective</td>
<td>Included in planning</td>
<td>Benefits fell short</td>
</tr>
<tr>
<td>Navigation</td>
<td>Included in planning</td>
<td>No benefit</td>
<td>Not a purpose</td>
<td>Not relevant</td>
</tr>
<tr>
<td>Flood control</td>
<td>Included in planning</td>
<td>Some benefit realised</td>
<td>Not a purpose</td>
<td>Not relevant</td>
</tr>
<tr>
<td>Re-regulation</td>
<td>Not a purpose</td>
<td>Not relevant</td>
<td>Not a major purpose</td>
<td>Part of Mahaweli scheme</td>
</tr>
<tr>
<td>Released GHG emission</td>
<td>Not planned</td>
<td>Did replace thermal generation</td>
<td>Not planned</td>
<td>Was an alternative to thermal generation</td>
</tr>
<tr>
<td>Tourism</td>
<td>Mentioned in feasibility study but not planned</td>
<td>Signs of tourism starting</td>
<td>Not planned</td>
<td>Some tourism disrupted by security problems</td>
</tr>
<tr>
<td>Fisheries</td>
<td>Not planned</td>
<td>Significant development</td>
<td>Not planned</td>
<td>Reservoir fisheries developed</td>
</tr>
<tr>
<td>Recreation</td>
<td>Not planned</td>
<td>Not relevant</td>
<td>Not planned</td>
<td>Not relevant</td>
</tr>
<tr>
<td>Municipal water supply</td>
<td>Not planned</td>
<td>Not relevant</td>
<td>Not planned</td>
<td>Not relevant</td>
</tr>
<tr>
<td>Rural electrification</td>
<td>Included in planning</td>
<td>Limited success</td>
<td>Included in Planning</td>
<td>Part of Mahaweli electrification</td>
</tr>
<tr>
<td>National development</td>
<td>Significant purpose</td>
<td>Successful</td>
<td>Part of planning</td>
<td>Contributed almost as planned</td>
</tr>
<tr>
<td>Regional development</td>
<td>Significant purpose</td>
<td>Successful</td>
<td>Part of planning</td>
<td>Successful</td>
</tr>
<tr>
<td>Development of the immediate reservoir area</td>
<td>Not planned</td>
<td>Only unplanned inflows of settlers</td>
<td>Not planned</td>
<td>Part of whole Mahaweli development</td>
</tr>
<tr>
<td>Electricity exports</td>
<td>Expected</td>
<td>Most significant</td>
<td>Not planned</td>
<td>Not relevant</td>
</tr>
</tbody>
</table>
3. Project Development Effectiveness

This chapter reviews the impacts and effectiveness of the four dams studied. Again the sections are sectoral in content, dealing first with the primary purposes of the dam (hydropower and irrigation), secondary purposes (navigation, flood control), and then the impacts (sedimentation and erosion, public health, social effects and environmental impacts). Points of similarity and differences between the four cases are noted as a basis for general remarks given later in this report.

3.1. Power Generation

There were some differences between the planned and actual energy generation by the four projects. Thus, the expected generation for a 120-MW installed capacity at Nam Ngum1 was 630 GWh/year, while the actual power generation has averaged 239.68 GWh/year at 30 MW, 784.53 GWh/year at 110 MW and 820.36 GWh/year at 150 MW.

The actual generation from Victoria was lower than planned; for a 210-MW power plant, a generation of 1,114 GWh/year was expected, while the actual generation from the scheme is of 672.5 GWh/year only. This lower generation was due to increased diversion requirement at the upstream Polgolla and lower natural stream flow than expected. From the same perspective, the generation by Lingjintan for 1999 was also lower than expected (140.6 GWh actual versus 650 GWh expected, due to a fault in unit 1 of the power plant). The current generation at Magat is of about 1,000 GWh/year; however, expected generation from 360-MW installed capacity was not available. Table 3-1 shows the expected and actual power generation by the four projects.

Table 3-1: Expected And Actual Power Generation by the Four Hydropower Projects (in GWh/year)

<table>
<thead>
<tr>
<th></th>
<th>Nam Ngum1</th>
<th>Victoria</th>
<th>Magat</th>
<th>Lingjintan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expected</td>
<td>630 (120 MW)</td>
<td>1,114 (210 MW)</td>
<td>991 (300 MW)</td>
<td>650 (120 MW)</td>
</tr>
<tr>
<td>Actual</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(average</td>
<td>239.68 (30 MW)</td>
<td>672.5 (210 MW)</td>
<td>1,000 (360 MW)</td>
<td>140.6 (120 MW)</td>
</tr>
<tr>
<td>indicated)</td>
<td>784.53 (110MW)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1978-1983)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>820.36 (150MW)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1984-1997)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: The fifth unit of Lingjintan was expected to be commissioned at the end of December 1999. Therefore, the generation planned for 1999 corresponds to a 120-MW installed capacity, meaning four units only. Power generation by Lingjintan was lower than expected due to a design fault in the generator, which required a stoppage of unit 1 between February and April 1999.

In each case studied, the minimum transmission requirement was met. In the case of Nam Ngum1, the 1962 feasibility study planned the construction of a 110-kV transmission line, while a 115-kV line was actually built. In the other cases, the transmission lines were constructed as planned; 220 kV, 230 kV, and 220 kV lines were installed for Victoria, Magat
and Lingjintan, respectively. However, the construction of the 220-kV transmission line planned for Victoria experienced some delays; thus, during the first year, a smaller 132-kV transmission line was temporarily used.

In the Lao PDR, the Philippines and Sri Lanka, rural electrification expended after the implementation of the respective hydropower projects. In the Lao PDR, rural electrification grew from 33 per cent in 1983 to 67 per cent in 1990. In Sri Lanka, the rate of rural electrification grew from 15 per cent in 1983 to 29 per cent in 1990. On Luzon Island, (the Philippines) rural electrification grew from 30 per cent in 1980 to 61 per cent in 1990. In the case of Lingjintan, it is probably too recent a project to allow such an analysis. Although it is difficult to quantify the contribution of single project to the expansion of rural electrification, Nam Ngum, Victoria and Magat probably facilitated the increases seen above.

3.2. **Irrigation and Agriculture**

Of the four dams studied, only one, Magat, was constructed with the specific primary purpose of developing irrigated agriculture. The downstream irrigation development in Systems B and C in Sri Lanka was a component of the overall Accelerated Mahaweli Development programme, of which the Victoria dam was a part. However, the irrigation systems themselves were planned as separate projects the overall development of the dry zone. Therefore, it is difficult to attribute irrigation benefits to the Victoria dam as such. The same is true of Nam Ngum1. Once the option of gravity feed irrigation from the Nam Ngum1 dam had been rejected, the assumption was that the electricity generated and regulated water flow would enable pump irrigation from the Nam Ngum1 River. However, rural electrification did not begin until 1980 and it remained dependant on a series of other development projects.

Even if irrigation benefits are attributed to the Victoria and Nam Ngum1 dams, all three case studies confirm the common pattern in large-scale water resource development projects, that such benefits are overestimated. In the MARIS system and Systems B and C in Sri Lanka, efficient distribution of irrigation water to farmers' fields occurred 2-4 years behind schedule, while the areas irrigated were less than expected (particularly in MARIS), and yields of the rice crop in both the wet and dry seasons were lower than anticipated. In both those systems, irrigated agricultural development was dominated by low-value rice. Even 15 years after project completion, there has been little diversification into higher value crops and alternative agricultural enterprises.

Irrigated agricultural development has been constrained by a whole variety of factors, including technical problems in the irrigation distribution system, markets and input supply systems, as well as a lack of security of tenure and availability of reasonably priced agricultural credit. In relation to the first factor, inadequate budgets for system operations and maintenance, as well as inadequate water charges in MARIS and Systems B and C, have created the need for new projects that ensure system rehabilitation.
3.3. **Navigation**

Only for Lingjintan was navigation mentioned as an intended primary benefit from the dam project. The dam was to raise the river level to cover the rapids and facilitate traffic. Ship locks were also constructed to allow the passage of ships to the upper reach of the river. However, no data were presented, in the studies reviewed, that would have provided quantification of the navigation benefits. Information from field interviews suggested that traffic had declined and changed in character from the transport of bulky goods to more passenger traffic from tourism. One possible reason could be diversion of traffic from the river by the development of the rural road network.

3.4. **Flood Alleviation**

Since the commissioning of the Nam Ngum1 project in 1971, no detailed studies on the reduction of flooded areas have been carried out. Therefore it is not possible to estimate how much flood damage has been prevented by the project. The lack of data and, hence, limited assessment of flood control effects at the time of the feasibility study may have resulted in the potential flood control role of the project not being fully exploited in its actual operation.

During the feasibility stage, consideration was given to the greater benefits from flood control as well as low-flow augmentation for irrigation and downstream navigation, which would be achieved with a maximum operation level higher than the selected one. However, those additional benefits were considered to be outweighed by the necessary increase in construction time and, hence, the interest shown during construction. A later study, presented at a recent international conference in 1998, showed that during severe storms that occurred over the Nam Ngum basin in late August and early September 1995, the reservoir absorbed two major floods and attenuated the peak inflow of a third flood by 20 per cent. However, no construction measures to protect specified areas against flooding were identified.

Flood control was not a major objective of the Mahaweli Development Programme. Thus, the operating policy for the Victoria project does not appear to have incorporated any elements designed specifically to reduce floods in downstream areas. During the decision stage, full accounting of the costs of inundation as well as consideration of the trade-off with environmental impacts might have led to the selection of a lower dam.

It appears that an analysis of flood damage before and after construction of the Victoria project was not carried out.

During the feasibility stage of the Magat project (1973), flood control was considered to be an area of major concern in the river basin. Periodic inundations of low-lying areas along the Magat River were a common occurrence. Before project commissioning, several major floods occurred up to a magnitude of two thirds of the spillway capacity. Flood control comes under the Bureau of Public Works, which has constructed about 22 km of protection dikes that have proved to be effective.

Compared to the upstream Wuqiangxi project, Lingjintan’s regulating storage capacity is only about 2 per cent. Therefore, its flood operation is tightly linked to upstream events. Whenever the Wuqiangxi project releases flood water, Lingjintan’s flood relief discharge will largely be equal to the inflow plus the concurrent flood from the intervening drainage area.
Decisions on flood control affecting storage to be provided as well as the amount and timing of flood releases are taken by the Hunan Province Flood Dispatching Centre. According to MSDI, a short-term flood forecasting methodology is in place and the need for the implementation of long-term regional forecasting models is being discussed.

### 3.5. Social Impact

#### 3.5.1. Project Affected Persons

With the exception of Victoria, the case studies showed that the dams had resulted in the displacement of relatively modest numbers of people from the dam sites and reservoir areas. The Nam Ngum1 dam was built at a time when the lower Nam Ngum basin was sparsely populated, while the watershed of the Magat River had only been recently developed when the Magat dam was being planned. Those two dams displaced 579 and 431 households, respectively. The Lingjintan Dam in Hunan is a run of the river structure, which created a head pond in the river course behind the dam; those families who lost land and housing were relocated within the same communes and often over only short uphill distances. However, because of prevailing high population densities, some 830 households lost either agricultural land or housing. The Victoria dam displaced a total of 30,000 people comprising approximately 6,000 families. The Victoria dam was built in an area that was relatively densely populated, and the inundated area included suburban areas of the city of Kandy.

The planners of three of the four dams studied underestimated the numbers of project affected persons. The worst case was at Victoria, where the lack of a detailed survey during the preliminary feasibility study meant that the original estimate of project affected persons was less than one-quarter of the final figure. At Lingjintan, adherence to minimal standards for estimating flood levels meant that the relocated population was roughly 25 per cent higher than the original figure. In the case of the Magat dam, the numbers of families displaced increased several times between the initial survey and resettlement; newly-formed households, termed “second priority” settlers, were not included in the final figure.

In addition, the estimates of project affected persons did not cover groups other than those displaced by the dam and reservoir. In no case was consideration given to the possible affects on the downstream population or to those losing land to the construction of canals and other irrigation works. In all cases, downstream communities appear to have been affected by changes in water flow, which impacted on riverine fisheries and, in the case of Lingjintan, cross-river navigation. This finding is entirely in line with that of the WCD in 2000.

#### 3.5.2 Loss and Development of Livelihood

In Magat, the Nam Ngum1 and Victoria projects covered by this study, there also appears to have been considerable and long-term loss of livelihood. Short-term assistance was not as comprehensive and inclusive as might have been expected. Compensation was not made available to settlers from Nam Ngum1, who were expected to fend for themselves in clearing land in the new area. In the case of Victoria, although compensation was extended to almost all groups affected, compensation was not made for tree crops despite their importance in the local tree garden economy. At Magat, asset compensation was reasonably inclusive, but newly-formed households were not given agricultural land and settlers had to pay for their
allocations out of their compensation money. Since the compensation money was less than the price of the land allocated, most started their life in the settlement, needing to make amortisation payments. Failure to develop land in advance of the settlers movement meant that it was between two years (Magat) and four years (parts of System C) before families were able to secure an irrigated crop in the dry season. While settlement authorities attempted to bridge the livelihood gap with wage labour opportunities, settlers faced many difficulties in the years immediately after their movement.

In the case of the settlement of System C, the difficulties of rehabilitation in the early years were compounded by failures in the provision of social services. Despite the considerable attention paid to the development of social and economic infrastructure in the area, this was not matched by the accompanying operating funds for educational and medical services. Many families were badly affected by a significant outbreak of malaria and other water-borne diseases in the first three years of settlement. Magat appears to have done better in that regard, since the settlement area was already densely populated.

Other health problems reported in the project areas were helminthic infections (Nam Ngum1 project) and leptospirosis (Lingjintan project). However, only the Lingjintan project attempted to conduct health monitoring surveys during the construction period. In that connection, some public health-related concerns such as the inadequate management of toxic substances, domestic and construction wastewater, and solid wastes were noted.

In the longer-term perspective, the problem of restoration of livelihood appears to have been greatest in the case of Victoria, where a large part of the inundated area was occupied by tree gardens, which offered a secure and relatively prosperous livelihood. The bulk of displaced agricultural households were either given land in areas with relatively poorer soils in former estate lands near Kandy or required to move to the newly developed settlement area, System C, to earn their living from irrigated rice cultivation. Despite the scope for double-cropping, the rice economy has not offered a viable livelihood, especially since plans to develop non-farm employment for second-generation settlers have proved over-ambitious. Second-and third-generation settlers are being forced to seek employment through migration to industrial and service jobs, including those in the security forces.

Of the fours dams studies, the Victoria Dam involved the largest number of people being resettled. That appeared to bear out the World Commission on Dams conclusion that “the larger the magnitude of the displacement, the less likely it is that even the livelihoods of affected communities can be restored”.

The situation at Magat and Nam Ngum1 was somewhat similar. Although people resettlers at Magat were given 3 ha of irrigated rice land, suitable for two crops annually, many are still struggling to make a living. Sub-division, partly through lack of adequate provision for the second generation, has reduced holdings to a little over one-third of their original size. Many households still lack secure tenure as a result of failure to maintain their land amortisation payments. Thus, they lack access to formal credit and have to pay higher production costs because of higher interest rates. As in System C in Sri Lanka, the regional economic environment has offered little opportunity for agricultural diversification. Some settlers appear to be no better off in the commercialised economy than when they were living at the subsistence level in the watershed before the project. The same is broadly true of the pump
irrigation schemes along the Nam Ngum1 River downstream of the dam in the Vientiane Plain, although capital shortages after 1975 meant that those opportunities were only developed as late as 10 years after dam construction was completed. In the absence of irrigation, few attempts were made to support any development of settlers’ livelihoods.

The situation at Lingjintan in Hunan province of China was rather better. A more comprehensive and detailed resettlement plan, particularly during the detailed design stage, offered a number of promising opportunities for livelihood development, particularly in aquaculture and horticulture. However, even here, the need to increase the budget for resettlement together with delays in approval of the new budget have meant that the tree-crop enterprises are coming onstream later than anticipated. In some contexts, it has not been possible to implement the intended plans, because of the larger area flooded. Families have had to seek non-farm employment to make ends meet.

3.6. Environmental Impacts

In the case of the Lingjintan, Magat and Victoria projects, the EIA studies never thoroughly assessed the impacts arising from construction activities. It is probable, though, that the construction of these dam projects has resulted in the following adverse environmental impacts:

(a) Soil erosion, downstream sedimentation and water quality degradation arising from quarrying and site clearing activities,

(b) The perturbation, modification and fragmentation of habitats for aquatic/fishery/forestry species, and the concomitant livelihood impacts on downstream communities that are largely dependent on the maintenance of the integrity of upstream natural resource assets.

Illustratively, for the Lingjintan project, dam construction has actually resulted in the destruction of some fish spawning areas. Moreover, the construction of the dam project’s ancillary facilities (e.g., the erection of transmission lines and towers and in the case of the Nam Ngum 1 project, preparation of both the road alignment and the access roads) has probably entailed adverse environmental impacts, from activities such as tree cutting in forested areas.

Water quality impacts in the reservoir areas of the four dams differed during the operational stage of each project.

For the Lingjintan project, pollution from natural, agricultural and industrial sources has affected water quality; however, the post-impoundment reservoir and downstream water quality has generally remained within the prescribed water quality standards.

In the case of the Magat project, post-impoundment reservoir water quality remains suitable for uses such as the propagation and growth of fish and other aquatic resources, recreational activities and industrial water supply. For the Magat project, there was simply no information available regarding the clearance of trees and vegetative cover from the reservoir area prior to impoundment. However, the occurrence of thermal and chemical stratification in the Magat project was quite evident.
In the case of the Lingjingtan project, the inundated area was comparatively small and environmental impacts of vegetative clearance were not therefore an issue. For the Nam Ngum1 project, the non-clearance of trees and vegetative cover from the reservoir area before impoundment has contributed to stratification, the reduction of DO levels and the creation of anaerobic conditions in the hypolimnion.

In the Victoria project, while trees and vegetative cover were clear-felled in the reservoir area, adverse water quality impacts were precluded by not allowing organic matter to decompose in the inundated area. However, algal blooms were observed in the initial years after inundation, but the impact on water quality was extremely difficult to assess as no water quality monitoring data were available.

The impacts on water quality downstream of the projects also varied in response to specific factors. In the Lingjingtan project, the water quality monitoring results have shown no significant impact on downstream water quality, with such post-impoundment water quality meeting the established water quality standards. There was no available downstream water quality data. For the Magat project, in the Nam Ngum1 project, the periodic release of reservoir water characterised by low DO from the hypolimnion may have possibly affected downstream aquatic biodiversity and productivity, but such has not been categorically established by the collected data. In the case of the Victoria project, downstream water quality conditions (for about 5 kms) were definitely affected by the construction of a bypass between the dam and the powerhouse. Thus, the consequent redirection and reduction of river flow could be construed as an environmental impact that was not particularly encouraging for malaria vector control.

The status of forest cover and vegetation over time in the upstream catchment areas of the four projects has exhibited mixed results. For the Lingjingtan project, forest cover in the catchment areas has shown a gradually decreasing trend. Magat’s watershed forests also experienced a considerable decline due to the conversion of those forest areas to grassland and brushland, the practice of land-degrading cropping systems, illegal logging and commercial ranching, all as a result of better access to forest areas and migration. However, for both the Nam Ngum1 and Victoria projects, incremental forest cover improvements have been attained in the watershed areas in recent years. In the case of the Nam Ngum1 project, the legacy of war and its aftermath in the Indochinese peninsula has allowed forest growth, recovery and regeneration. In the Victoria project, the creation of the Victoria-Randenigala-Rantembe sanctuary has been largely instrumental in increasing the area covered by natural forests in the watershed.

For wildlife resources in the upstream catchment and reservoir areas of the four projects, a discernible decrease in wildlife biodiversity and population has been observed (although the conduct of more detailed wildlife surveys would definitely help in ascertaining a more accurate picture of the biodiversity situation in the project areas). It is probable that continued forest and habitat destruction and hunting are the primary causes behind such a negative trend.

With the exception of the Nam Ngum1 project, where no fish species inventory was undertaken during the preimpoundment period, the Lingjingtan, Magat and Victoria project findings indicate less abundance in terms of fisheries resources during dam construction and operations in the upstream areas. It is likely that the operation of the dams has created barriers
to fish migration (with no fish access or passage being constructed to assist such fish migration), especially for Victoria where a certain stretch of the river was dewatered. Such barriers, when coupled with destructive fishing practices and overexploitation, have led to adverse impacts on fish biodiversity and productivity. Notwithstanding these constraints, reservoir fisheries were developed (to the point of overexploitation for the Magat, Nam Ngum1 and Victoria projects) because of active project interventions, even though fisheries management practices among the projects were distinctively different. However, it should be noted that in the Lingjintan project, no fisheries and aquatic resource inventory was carried out for pre-impoundment conditions. In the case of the Magat project, it was observed that downstream fisheries resources became less abundant with pre-impoundment conditions.

3.7. Economic Performance

Relative to the overall economy, a dam project may only play a small part. The case of Lingjintan is an example. At the other extreme, Nam Ngum1 was a major investment for the economy of the Lao PDR in terms of investment and revenue generated. Magat and Victoria were both major regional projects, which became national symbols of development.

The macroeconomic situation of each country provides the important context for dams. Nam Ngum1 is a clear case of using the national resource base to provide foreign exchange. Magat provides a higher degree of self-sufficiency in the energy and food sectors of the Philippines economy. Victoria plays a major role in the power sector at a time of rising oil price, thus reducing the need to import energy. Thus, dams are an option in the overall macroeconomic context.

The investment required for a dam project is substantial, and mobilisation of funds is often a major task for the domestic economy. For that reasons, foreign financial sources play an important role.

The macroeconomic impacts of dam projects are generally positive. Dams expand a country’s productive capacity and relieve important bottlenecks. At the same time, building a dam cannot be taken for granted as the best answer to the macroeconomic needs for import substitution or exports.

The economic performance of projects can be measured in terms of the economic rate of return, calculated from a cost-benefit analysis of a project. The economic rates of return for the four case studies are summarised in Table 3-2. They have been calculated for a period of 40 years at 1998 prices in the local currencies.
Table 3-2: Comparison of Expected and Actual Economic Rates of Return of the Four Case Study Projects

<table>
<thead>
<tr>
<th>Case Study Project and Years of Analysis</th>
<th>Planned EIRR (%)</th>
<th>Actual EIRR (%)</th>
<th>References to Annex</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lingjintan (1994-2033)</td>
<td>16.73</td>
<td>11.93</td>
<td>P. Table No. 3.9-4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>A Table No. 3.9-5</td>
</tr>
<tr>
<td>Magat (1974-2013)</td>
<td>12.12</td>
<td>4.74</td>
<td>P. Table No. 3.9-6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>A Table No. 3.9-7</td>
</tr>
<tr>
<td>Nam Ngum1 (1967-2006)</td>
<td>3.40</td>
<td>9.33</td>
<td>P. Table No. 3.9-3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>A. Table No. 3.9-4</td>
</tr>
<tr>
<td>Victoria (1979-2018)</td>
<td>11.86</td>
<td>6.59</td>
<td>P. Table No. 3.9-1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>A. Table No. 3.9-3</td>
</tr>
</tbody>
</table>

Table 3-2 shown there is considerable divergence in the expected and actual EIRRs of the projects. The case of Nam Ngum1 is the only one where the actual EIRR exceeds the expected rate. For Magat, Victoria and Lingjintan, the “actual” EIRRs are lower than the expected values.

The reasons for the divergence between the expected and actual EIRRs are varied. For Nam Ngum1, the better than expected performance is due to the higher ratio of exported to domestic sales of the electricity generated. For Magat, the lower than expected performance of the project is due to the failure to develop the incremental irrigated rice production to the extent envisaged in the planning stage. For Victoria, power production was lower than planned. For Lingjintan, the slight decrease in the EIRR calculated from actual costs compared to the planned EIRR may be due to the higher costs of resettlement. The specifics have been described elsewhere in this report.

The divergence between the actual and planned EIRRs indicates the need to pay close attention to implementation and operation stages to ensure that the investment in the project produces the expected benefits. As the case studies show, such divergence can arise from a multiplicity of causes, and monitoring must therefore be comprehensive.

3.8 Summary of Planned and Actual Project Benefits

Table 3-3 below gives a comparative summary of the planned and actual benefits of the four case study projects.
### Table 3-3: Planned and Actual Benefits of the Case Study Projects

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Nam Ngum 1</th>
<th>Victoria</th>
<th>Magat</th>
<th>Lingjintan</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Planned</td>
<td>Actual</td>
<td>Planned</td>
<td>Actual</td>
</tr>
<tr>
<td>Power generation</td>
<td>Principal purpose</td>
<td>Target exceeded</td>
<td>Principal purpose</td>
<td>Power per year</td>
</tr>
<tr>
<td>Irrigation</td>
<td>Included in planning</td>
<td>Not effective</td>
<td>Included in planning</td>
<td>Benefits fell</td>
</tr>
<tr>
<td>Navigation</td>
<td>Included in planning</td>
<td>No benefit</td>
<td>Not a purpose</td>
<td>Not relevant</td>
</tr>
<tr>
<td>Flood control</td>
<td>Included in planning</td>
<td>Some benefit realised</td>
<td>Not a purpose</td>
<td>Not relevant</td>
</tr>
<tr>
<td>Re-regulation</td>
<td>Not a purpose</td>
<td>Not relevant</td>
<td>Not a major purpose</td>
<td>Part of Mahaweli scheme</td>
</tr>
<tr>
<td>Released GHG emission</td>
<td>Not planned</td>
<td>Did replace thermal generation</td>
<td>Not planned</td>
<td>Was an alternative to thermal generation</td>
</tr>
<tr>
<td>Tourism</td>
<td>Mentioned in feasibility study but not planned</td>
<td>Signs of tourism starting</td>
<td>Not planned</td>
<td>Some tourism disrupted by security problems</td>
</tr>
<tr>
<td>Fisheries</td>
<td>Not planned</td>
<td>Significant development</td>
<td>Not planned</td>
<td>Reservoir fisheries developed</td>
</tr>
<tr>
<td>Recreation</td>
<td>Not planned</td>
<td>Not relevant</td>
<td>Not planned</td>
<td>Not relevant</td>
</tr>
<tr>
<td>Municipal water supply</td>
<td>Not planned</td>
<td>Not relevant</td>
<td>Not planned</td>
<td>Not relevant</td>
</tr>
<tr>
<td>Rural electrification</td>
<td>Included in planning</td>
<td>Limited success</td>
<td>Included in Planning</td>
<td>Part of Mahaweli electrification</td>
</tr>
<tr>
<td>National development</td>
<td>Significant purpose</td>
<td>Successful</td>
<td>Part of planning</td>
<td>Contributed almost as planned</td>
</tr>
<tr>
<td>Regional development</td>
<td>Significant purpose</td>
<td>Successful</td>
<td>Part of planning</td>
<td>Successful</td>
</tr>
<tr>
<td>Development of the immediate reservoir area</td>
<td>Not planned</td>
<td>Only unplanned inflows of settlers</td>
<td>Not planned</td>
<td>Part of whole Mahaweli development</td>
</tr>
<tr>
<td>Electricity exports</td>
<td>Expected</td>
<td>Most significant</td>
<td>Not planned</td>
<td>Not relevant</td>
</tr>
</tbody>
</table>
4. Lessons Learnt from this Study

4.1 Discussion

As a first step in developing the lessons learnt from the case studies, a matrix was prepared in which the findings of each of the case study projects were set out against various aspects of their development, from which lessons could be drawn from the shortcomings of the projects, and recommendations developed for overcoming these shortcomings in future projects. A review of these matrices (in each case study report) indicates that most of the shortcomings of the projects can be attributed to inadequacies in the processes employed in their development.

Recapitulation of the project development process is therefore appropriate at this point. The formula of observations as a matrix with accompanying text has given the individual case study reports a sectoral focus. Although the various components of the development process are mentioned, they are scattered and do not give a simple “bird’s-eye view” of the way the projects were developed, or the strengths and weaknesses of their development process. To achieve this in summary form, a flow chart illustrating an ideal or model project development and decision-making process is presented (Figure 4-1), followed by the actual project development flow chart of each case study project in turn (Figures 4-2 to 4-5). The important differences between the two are emphasised in the brief accompanying notes. It is important to note that the inclusion of a process in the flow chart does not imply either effectiveness, or acceptability under current standards.

For ease of comparison, the actual charts are shown in the same format as the ideal process, with the missing ideal components shaded and additional components in italic. At a glance, it can immediately be seen that there are widespread deficiencies in (a) public participation in the planning process, (b) environmental protection measures and monitoring, and (c) initial and ongoing restoration of livelihoods. This is exactly in accord with the WCD findings, as indicated in the Appendix.
Figure 4-1: Model Project Development and Decision-making Process

National policies
Macro-economic Analysis

NEEDS EVALUATION

Decision on need

Preliminary EIA for ecology
Sector system analysis
Public consultations
Search for alternatives

OPTIONS ASSESSMENT

Selection of option

Engineering options
Socio-environmental assessment
Cost/economic evaluation
Public consultation

PREFEASIBILITY STUDIES

Decision with public participation on preferred scheme

Engineering studies
Completed EIA
Cost/economic analysis
Public discussion

FEASIBILITY STUDIES

Decision, with public participation, to proceed with project

Engineering design
Environmental planning
Social planning
Cost/economic review
Public liaison

FINAL DESIGN

Decision to construct

Construction supervision
Environmental protection
Social measures
Cost/economic monitoring
Public liaison

CONSTRUCTION

Decisions on the basis of monitoring and the evaluation

Continuing:
Livelihood improvement
Environmental protection monitoring
Periodic project evaluation

OPERATION

Continuing:
Livelihood improvement
Environmental protection monitoring
Periodic project evaluation
Figure 4-2: Nam Ngum 1 Development and Decision – making Process

National Policies
Macro-economic Analysis

NEEDS EVALUATION

Decision on need

OPTIONS

Assessment (this was done during the feasibility study)

Selection of options

PRE-FEASIBILITY STUDY

Decision, with public participation, on preferred scheme

FEASIBILITY STUDY

1962-1973-1980 respectively first, second and third stage, respectively

Decision, with public participation, to proceed with project

FINAL DESIGN

(final design for stage 1 in 1968)

Decision to construct

CONSTRUCTION

OPERATION

Continued:
Resettlement programme
Livelihood Improvement
Environmental Protection
Monitoring and periodic project evaluation

Decisions on basis of monitoring and evaluation
Comment on Figure 4-2 (Nam Ngum1)

The Nam Ngum1 dam was the first major multilateral and regional project implemented under the auspices of the former Mekong Committee. The project was initially developed as part of the 1969-1974 Lao PDR Development Plan, which was aimed at building a more independent economy through the development of the productive, infrastructure and social sectors. In the 1960s, because of a lack of generating capacity, the Lao PDR had to import electricity from Thailand. Thus, the project was able to provide an operational means of complying with the general objective of providing the Lao PDR with sufficient capacity to replace electricity imports. From that perspective, the project was consistent with overall economic planning. However, the following points should be noted:

(a) Regional and sectoral environmental assessments [EAs] were not conducted;
(b) The project did not conduct either a baseline environmental survey or an initial environmental examination (IEE). However, baselines for water quality and some ecological resources were assessed by other studies;
(c) An EIA was not conducted. Thus, there were neither environmental protection measures nor a monitoring plan for the construction and operation phases;
(d) Plans for environmental action and environmental enhancement were not incorporated into the engineering detailed design;
(e) There were no proposal and implementation of environmental protection measures and monitoring plan during construction; and
(f) There was no environmental protection and monitoring plan for the operation period. However, downstream water quality and reservoir fisheries have been monitored in recent years by some other studies.

The absence of coherent environmental and social planning was, of course, characteristic of the era. However, the continuing absence of a definitive and successful livelihood restoration programme and an environmental protection plan is not in accord with the ideal project process.

Other points to note are:

(a) The social impact assessment part of the EIA (in terms of the project affected persons survey) was not carried out until 1966-67, after the feasibility study;
(b) There appears to have been no formal resettlement plan;
(c) A formal resettlement was carried out after 1975, four years after the completion of Phase I;
(d) The resettlement process continued until well into the 1980, so that it essentially ran parallel with the operation phase.
(e) Apart from the project affected persons, there was almost no public consultation.
Figure 4-3: Victoria Development and Decision – making Process

1. **National Policies**
   - Macroeconomic Analysis

2. **Needs Evaluation**
   - Decision on need

3. **Options Assessment** (actually carried out during the needs evaluation process)
   - Selection of options

4. **Pre-feasibility Study** (1978)
   - Decision, with public participation, on preferred scheme

5. **Feasibility Study** (not available)
   - Decision, with public participation, to proceed with project

6. **Final Design** (Report on additional work, 1979)
   - Decision to construct

7. **Construction**
   - Resettlement compensation
   - Construction supervision
   - Environmental protection
   - Social measures
   - Compliance monitoring
   - Public liaison
   - Cost/economic monitoring

8. **Operation**
   - Decisions on basis of monitoring and evaluation

9. **Continuing:**
   - Livelihood improvement
   - Environmental protection
   - Monitoring and periodic project evaluation

10. **Resettlement**
    - Assessment
    - Engineering options

11. **Engineering Studies**
    - Project EIA
    - Cost/economic analysis
    - Public discussion
    - Environmental and social impact studies

12. **Resettlement Planning**
    - Engineering design
    - Environmental planning
    - Social planning
    - Cost/economic review
    - Public liaison

13. **Energy Sector System Analysis**
    - Strategic EIA
    - Sector system analysis
    - Public consultations
    - Search for alternatives
    - Environmental assessment
    - Public consultations

14. **Environmental Assessment**
    - Public consultations

15. **Socio-environmental Assessment**
    - Cost/economic evaluation

16. **Cost/economic Evaluation**
    - Public consultations

17. **Public Consultations**
    - Environmental assessment
    - Public consultations

18. **Public Discussions**
    - Cost/economic analysis

19. **Public Consultations**
    - Environmental and social impact studies

20. **Search for Alternatives**
    - EIA

21. **National Policies**
    - Macro-economic analysis

22. **Macro-economic Analysis**

23. **Energy Sector System Analysis**
    - Public consultations

24. **Strategic EIA**
    - Sector system analysis
Comment on Figure 4-3 (Victoria)

The first studies concerning the development of the Mahaweli area were started in 1958. In 1964, the possibility of constructing a dam at Victoria was mentioned. The first master plan for development over 30 years of the Mahaweli Ganga basin was prepared jointly between 1965 and 1968 by a team of United Nations Development Programme/Food and Agriculture Organisation of the United Nations (UNDP/FAO) and Sri Lankan experts.

The overall plan included the development of about 350,000 ha of irrigable land, and the construction of 15 reservoirs and 11 hydropower plants with a total installed capacity of around 500 MW. In particular, the plan envisaged, in its first stage, the development of storage and hydropower potential on the Mahaweli Ganga at Victoria. However it should be noted that:

(a) Regional and sectoral EAs were not carried out;

(b) A highly simplistic EIA was carried out, covering a limited range of issues, by the Pre-Feasibility Study;

(c) There was no detailed EIA;

(d) There was no environmental action plan covering environmental protection enhancement plan. However, fisheries development by stocking with tilapia was recommended in the EIA;

(e) There was no proposal and implementation of environmental protection measures and a monitoring plan during the construction.

(f) The preliminary feasibility study did propose environmental protection (EPM) measures for forest cover, and vegetation and wildlife. EPM for water quality, fish and fisheries were proposed by the Accelerated Mahaweli Development Programme. Although no environmental impact monitoring was planned for the Victoria project, a Planning and Monitoring Unit was established within the Mahaweli Development Authority.

(g) There was no public consultation. Decisions were communicated to affected persons in a “top-down” and often haphazard way.

(h) Resettlement planning and some attention to the restoration of livelihood are evident as follows:

(i) Although a social impact assessment and a resettlement plan for the Kandy suburban area was included in the preliminary feasibility study of 1978, they were not based on any detailed assessment of impacts. The baseline survey of project affected persons was only conducted in 1981-1982, well after the start of the construction phase (1980);

(ii) The main resettlement plan was included in the separate feasibility study for the System C settlement area (1979), although it was probably not clear how many, if any; people from Victoria would need to be resettled.
(iii) Resettlement began in 1982 and was completed in 1984 when the reservoir began to fill up. The process was essentially in parallel with the construction period. However, land to be used for livelihood purposes was not fully cleared and developed until 1985-1986, so that under this narrow definition it was not completed until after the construction work had been completed. The process of restoration/improvement of livelihood is probably continuing.

(iv) MASL and donor organisations have regularly monitored progress in environmental protection since official completion of dam, while the ODA evaluation study of 1985 covered the social aspects.

There was little public consultation until the decision had been taken to proceed with the project and, indeed, after construction had started. There was a major negotiating process once the full dimensions of the resettlement were understood.
Figure 4-4: Magat Development and Decision – making Process

**National Policies**
- Macro-economic Analysis

**NEEDS EVALUATION**
- Decision on need

**OPTIONS ASSESSMENT**
- Selection of options

**PRE-FEASIBILITY STUDY**
- Decision, with public participation, on preferred scheme

**FEASIBILITY STUDY**
- (1973)
  - Decision, with public participation, to proceed with project

**FINAL DESIGN**
- (Study of 1976)
  - Decision to construct

**CONSTRUCTION**
- Resettlement programme
- Construction supervision
- Environmental protection
- Social measures
- Compliance monitoring
- Public liaison
- Cost/economic monitoring

**OPERATION**
- (1983)
  - Decisions on basis of monitoring and evaluation

**Continuing:**
- Livelihood improvement
- Environmental protection
- Monitoring and periodic project evaluation

**Energy sector analysis**
- Engineering studies
- Project EIA
- Cost/economic analysis

**Comparison with a thermal alternative**
- Public discussion
- Simplified environmental and Social impact studies

**Engineering options**
- Socio-environmental assessment
- Cost/economic evaluation
- Public consultations

**Environmental assessment**
- Strategic EIA
- Sector system analysis
- Public consultations
- Search for alternatives

**OPERATION**
- (1983)
  - Decisions on basis of monitoring and evaluation

**Decision to construct**
- Resettlement programme
- Construction supervision
- Environmental protection
- Social measures
- Compliance monitoring
- Public liaison
- Cost/economic monitoring

**FEASIBILITY STUDY**
- (1973)
  - Decision, with public participation, to proceed with project

**FINAL DESIGN**
- (Study of 1976)
  - Decision to construct

**PRE-FEASIBILITY STUDY**
- Decision, with public participation, on preferred scheme

**OPTIONS ASSESSMENT**
- Selection of options

**NEEDS EVALUATION**
- Decision on need

**National Policies**
- Macro-economic Analysis

**Energy sector analysis**
- Engineering studies
- Project EIA
- Cost/economic analysis

**Comparison with a thermal alternative**
- Public discussion
- Simplified environmental and Social impact studies

**Engineering options**
- Socio-environmental assessment
- Cost/economic evaluation
- Public consultations

**Environmental assessment**
- Strategic EIA
- Sector system analysis
- Public consultations
- Search for alternatives

**OPTIONS ASSESSMENT**
- Selection of options

**NEEDS EVALUATION**
- Decision on need
Comment on Figure 4-4 (Magat)

The plan to harness the hydropower potential of the Magat River was conceived as early as 1967. The Magat River Multipurpose Project (MRMP) was expected to boost the economic and social development of the Cagayan Valley. The project was to be multipurpose in nature, mainly for irrigation and power. A feasibility conducted from 1 July 1971 to 30 June 1973 assessed the potentials of the project and formulated plans for the development of the Magat River. The study was undertaken by NIA with technical assistance from the United States Bureau of Reclamation (USBR) and in co-operation with the United States Agency for International Development (USAID). However, there was no regional and sectoral EAs were undertaken, and there was no IEE.

An EIA was conducted during the Project feasibility study for the construction and operation periods. Some environmental protection measures were proposed for water quality, forest cover, wildlife, fish and fisheries, public health, recreation, erosion and sedimentation.

An environmental action plan covering environmental protection and protection enhancement, was not prepared for incorporation into the engineering detailed design.

The Project feasibility study did not assess the environmental impacts of construction activities. Thus, no environmental protection and monitoring measures were proposed for the construction period.

The Government of the Philippines implemented the Watershed Management and Erosion Control Project. The Magat watershed was selected as a case study of land use and land use change. A Memorandum of Understanding (MOU) of Freshwater Aquaculture was signed in December 1999. Recently, sediment inflows in the Magat reservoir were monitored by NIA. NAPOCOR has conducted a reservoir water quality survey and BFAB has monitored the water quality of cage culture areas.

Initially the social impacts were assumed to be minimal. However, costs have escalated. Livelihood restoration and improvement has not been continuous, and many settlers have accumulated debts from purchase of resettlement land.

A survey of project affected persons was undertaken by the University of the Philippines in 1972, in parallel with the feasibility study and its results were incorporated.

A resettlement programme, including a formal settlement plan, was implemented from 1977 to 1984, more or less in parallel with the period of detailed engineering design (1976) and construction (1978-1983). Actual resettlement took place during 1981-1982, but land development was delayed and only completed in 1984 during the construction period. Since then, there has been limited environmental monitoring of the resettlement areas.

Again, there was little public consultation until after construction work had commenced, i.e., the resettlement programme.
Figure 4-5: Lingjintan Ideal Project Development and Decision-making Process

NEEDS EVALUATION
- Decision on need

OPTIONS ASSESSMENT
- Selection of option discussed in the feasibility study

PRE-FEASIBILITY STUDY (1988)
- Decision with public participation on preferred scheme

FEASIBILITY STUDY
- Decision with public participation to proceed with project

DESIGN
- Decision to construct

CONSTRUCTION
- Decisions on the basis of monitoring and evaluation

OPERATION
- Continuing: Livelihood restoration

Macroeconomic analysis

Environmental assessment
- Sector system analysis
- Public consultation
- Search for alternatives

Engineering options
- Socio-environmental assessment
- Cost/economic evaluation
- Public consultation

Engineering studies
- Environmental and social impact studies
- Cost/economic analysis
- Comparison with a thermal alternative (coal)
- Energy sector analysis
- Public comments

Engineering design
- Resettlement planning
- Cost/economic review
- Public liaison

Construction supervision
- Resettlement process
- Cost/economic monitoring
- Public liaison
- Environmental mitigation

Environmental assessment
- Sector system analysis
- Public consultation
- Search for alternatives

Selection of option discussed in the feasibility study

Continuing:
- Livelihood restoration
- Environmental mitigation
- Monitoring and evaluation

Decision on need

Decision with public participation on preferred scheme

Decision with public participation to proceed with project

Decision to construct

Decisions on the basis of monitoring and evaluation

Monitoring and evaluation

Decision with public participation to proceed with project

Decision on need

Environmental mitigation

Decision with public participation to proceed with project

Decision on need

Monitoring and evaluation

Decision with public participation to proceed with project

Decision on need

Environmental mitigation

Decision with public participation to proceed with project

Decision on need

Monitoring and evaluation
Comment on Figure 4-5 (Lingjintan)

The investigation work on the potential of the Yuanshui River started in the mid-1950s. Later, a general hydropower resources survey carried out in 1980 throughout China revealed that the Yuanshui River water system had a total hydropower potential of 7,940 MW. The feasibility study for the Lingjintan project was completed in 1988. The former Ministry of Water Resources and Electric Power and the Planning and Design Institute for Water Conservancy and Hydroelectric Projects then identified Lingjintan for pre-construction study. Subsequently, the Hunan Provincial Electric Industry Bureau identified the Lingjintan project for commencement in the Eighth Five-Year Plan (1991-1995). NEIA was prepared by a team of specialists from the Mid-South Design and Research Institute for Hydroelectric Projects (MSDI), beginning in 1991.

Government of the People’s Republic of China wanted to improve on the results of the feasibility study completed in 1988, and it requested assistance from ADB in 1992 to finance a team of consultants (TA 1734 PRC).

As a result, the project was not approved before May 1993 when it was reviewed by the China International Engineering Consulting Corporation. Thus, in 1993, Lingjintan was integrated into the MSDI “Power Generation Expansion and Economic Evaluation” plan.

Although the project had been accepted, HEPC attempted to optimise its development. Therefore, China requested additional assistance (TA 1950 PRC) from ADB in order to review the findings from the 1992 report (TA 1734 PRC). The pre-evaluation of the project was completed in May 1994, and construction was started in October of the same year. Nevertheless, the State Planning Commission (SPC) did not officially approved construction until December 1995. However, no regional or sectoral EAs were carried out, no (IEE) was made, and no environmental action plan covering environmental protection enhancement was prepared or incorporated into the detailed engineering plan.

An EIA study was conducted, including baseline environmental surveys on water quality and ecological resources, and EPM were proposed for land use, erosion, water quality, fisheries and public health.

The EIA did not assess the environmental impacts of construction activities, and no environmental impact monitoring during the construction period was proposed. Based on an EIA conducted in 1994, the Tauyuan Epidermic and Disease Control Station was set up to monitor water quality during the construction period. The station has conducted health monitoring surveys.

The project construction has yet to be completed and the project is not yet fully operational.

While decisions appear to have been delayed, then accelerated during the feasibility stage, there has been much liaison with affected villagers (often with the “go ahead” decision). Local government authorities have been extensively involved. The effectiveness of ongoing livelihood restoration activities are not yet known as the project is only now entering the operational phase.
The social impact assessment was included in the feasibility study and a resettlement plan was a mandatory part of the initial project design. The plan was revised during the detailed design stage in 1995. A review of alternative designs in the feasibility study took into account the impact of different water levels on resettlement.

The resettlement process has been undertaken in parallel with construction work.

Public consultation was limited until the feasibility stage, when local authorities then became closely involved in the surveys of project affected person.

4.2 Main Lesson Learnt

From the foregoing discussion, the main lesson learnt from the case studies is that significant deficiencies in the performance of a project arise when its development and decision-making process fails to include all the required steps and activities of a comprehensive, progressive project development in which engineering, social and environmental aspects are co-ordinated.

4.3 Supporting Lessons Learnt

The above main lesson learnt from the general analysis of the case studies is supported by a number of supporting lessons which may be drawn from the detailed analysis of the case studies. These are set out below under various headings.

4.4 Policy and Institutional Framework

4.4.1 Water Resources Policy

Some of the negative impacts found in the four case studies dams emerged from the absence of a clear policy and institutional framework for such projects. There appear to be three main institutional issues involved.

(a) There is often an unclear division of responsibilities, especially in multipurpose projects.

In particular, in multipurpose dam projects, the responsibility for planning, implementation and operations may be divided between agencies responsible for electricity generation, the provision of irrigation, and general water resources planning. In some cases, the potential conflicts in supply and control of water have been solved through committee structures, with regular seasonal or even weekly meetings being held. In other cases, the operating authority, usually the electricity generating agency, releases water according to energy and hydrological needs, which results in unexpected impacts.
(b) **The financial benefits accruing to operating agencies are rarely available for social development and environmental protection measures.**

Revenue generated from the operation of dams usually accrues to the electricity generating agency. The responsibility of such agencies for the maintenance of project facilities usually extends only to the dam itself and associated headworks. Meanwhile the organisations charged with the maintenance of downstream structures as well as the implementation of environmental protection measures, and social and economic development for livelihood restoration often lack funds for such activities.

(c) **Responsibilities of the project operator rarely cover the whole river basin.**

In general, it appears that the responsibilities of the agencies involved in planning and operating large dams are not sufficiently wide. In the case study dams, the impact insufficient consideration has been given to the impacts of the dams on watersheds as well as of the watersheds on the long-term operations of the dams. In addition, probable downstream effects of the dams have rarely been taken into consideration.

**4.4.2. Energy Policy**

Exclusion of a hydropower project from an integrated national energy/power development plan or national water resources development plan demonstrates the lack of a clear and transparent policy framework for national energy and water resources development.

An integrated national energy plan or a power development plan sets out energy policy priorities and strategies of a country and looks at available energy supply (and demand) options from that perspective. A national energy plan or power development plan, therefore, provides a framework for appraising the feasibility and acceptability of energy projects from a national policy perspective. Of the four case studies, only Lingjintan was part of such a framework, being included in the least-cost expansion plan of Hunan Province. Victoria and Magat were later included in the power development plans of CEB respectively, but only after the construction of the dams was well under way. Therefore, with the exception of Lingjintan, the projects did not consider other energy supply options on a competitive or equal basis. It is true that the Nam Ngum 1 and Magat projects considered thermal alternatives, but most likely only to justify the projects and also not in accordance with an integrated energy plan or a least-cost power development plan. Victoria simply ruled out other energy supply alternatives.

**4.4.3. Resettlement Policy**

The lack of national guidelines and regulations covering the resettlement of displaced persons from large-scale water resources development project areas contributed to numerous negative aspects and uncertainties in the resettlement programmes.

Since the responsibility for implementing such projects may be divided among several agencies, according to the main purpose of the project, guidelines should be set by central planning authorities. Unfortunately, and in contrast to the environmental issues involved in large project development, where such agencies as STEA (Lao PDR) have been established, there is rarely clear responsibility for policy-making in relation to resettlement and other social impacts.
Where such guidelines exist, however, their use in a rigid and inflexible way can also lead to implementation problems.

### 4.4.4. Environmental Policy

The primary lesson in environmental policy that can be learnt from the present studies of large dam projects has been the widespread failure to incorporate significant environmental considerations into the project planning, design, construction and implementation components (in terms of a competent EIA and the requisite environmental protection measures). Such measures (if any) should have been subsequently enforced in project implementation to ensure environmental soundness. However, the failure to do so virtually guaranteed that environmental, social and economic soundness became severely compromised.

In retrospect, it is very instructive to note the reason for the failure to anticipate adverse significant biogeophysical and socio-economic impacts. The failure stemmed mainly from the inadequacy of the project development and decision-making process to ensure the capture of the relevant natural resource dimensions and environmental externality aspects in project planning (as it spans the various phases of needs evaluation, options assessment, pre-feasibility studies, feasibility study and the final design), construction and implementation. Such inadequacies were mirrored mainly by the widespread deficiencies in public participation in the project planning and decision-making process, the ad hoc nature of the remedial environmental protection measures (in terms of the mitigation and avoidance of unfavorable impacts), the disregard for proper environmental monitoring, and the half-hearted attempts to reverse the adverse social impacts of the loss of livelihood.

### 4.4.5. Institutional Management

Generally, the projects would have benefited from better institutional arrangement.

### 4.5. Project Planning and Design

#### 4.5.1. Water Resource Planning

*The following section, summarises the lessons learnt with respect to water resources planning, as obtained from the individual case study projects.*

Nam Ngum1

- As a multipurpose project, greater attention should have been paid in the planning and implementation stages, as to how the project should actually be operated in order to achieve the forecast benefits.

- Since the project has widespread benefits and costs, it needs to ensure that its economic feasibility accounts for all positive and negative impacts.

- Implementation of the irrigation components of a multipurpose project should have been given higher attention in the original concept.
If potential flood control benefits were to be realised, construction of the project should have been accompanied by all other necessary measures, e.g., land-use planning in downstream flood-prone areas and drainage improvement in those areas, the introduction of a flood warning system, the development of appropriate operating policies and the designation of responsibilities.

At the time of the feasibility study in 1962, the available hydrological data were inadequate for carrying out a reasonably precise assessment of the long-term average flow as well as flood control effects of the Nam Ngum1 reservoir, which was originally one of the major purposes of the project.

Victoria

Limited time for hydrological investigations led to the overestimation of natural stream flows at the project site and, subsequently by the project benefits.

Assumptions regarding the amounts of water diverted to the tributary Amban Ganga at the upstream Polgolla barrage proved incorrect and led to further overestimation of available water resources.

Irrigation and power system planning should have been more closely integrated into the planning of multipurpose projects, such as the Victoria scheme.

Magat

Irrigation should be as equally an important development objective as power benefits.

Irrigable areas were largely overestimated mainly due to the use of topographic maps with inadequate scales.

Lingjintan

The objective to serve as a re-regulation reservoir for the upstream Wuqiangxi plant has been achieved. The implementation of the Lingjintan project has enabled Wuqiangxi to serve as a peaking plant in the Hunan electricity grid.

For all natural and operational flow conditions, the planned maximum reservoir operation level of Lingjintan project has submerged upstream rapids sufficiently to allow safe navigation in that river reach. Thus, the Wuqiangxi project does not have to maintain a base load of 150 MW for navigation needs.

4.5.2. Hydropower Planning

The cost effectiveness of hydropower projects cannot be guaranteed if they are not integrated into a least-cost expansion plan.

Except for Lingjintan, the case study hydropower projects were not part of a least-cost expansion plan. Considering the limited domestic natural resources, the exclusion of Nam Ngum1, Victoria and Magat in the least-cost expansion plan raises some questions about their cost effectiveness or in other words, their being a least-cost option. That Lingjintan is a part of the least-cost expansion plan is indeed an improvement on the other case study projects. The energy-planning model (IRELP) facilitated the comparison of the cost of the Lingjintan hydropower project with that of other generating options.
The inclusion of the project into a least-cost expansion plan process also provided a specific energy framework for appraising and evaluating Lingjintan. Such specific frameworks were not found for the three other projects covered by the present study. In other words, this inclusion gave a firmer basis for the decision to construct Linjintan and facilitated its ex-post analysis from an energy perspective.

*Involvement of the central power utility in the planning process facilitates the integration of a hydropower project into the least-cost expansion plan for the power generation system.*

That Lingjintan was included in the least-cost expansion plan was facilitated by the fact that the Hunan Electric Power Company (HEPC) directly participated in the planning process. HEPC was also responsible for the construction and operation of the project. On the other hand, the power utility in each of the countries of the other three projects was only involved in the operation of Nam Ngum1 and Victoria, and the construction and operation of Magat. Had the power utility been involved in the planning process, the three other projects would have been included in their respective least-cost expansion plans. This is proved by the fact that Victoria and Magat, for example, were later incorporated into the plans of Sri Lanka’s CEB and NAPOCOR of the Philippines, respectively.

*Failure to carry out a comprehensive options assessment is an obstacle to public acceptance of hydropower projects.*

During the planning, construction and operation stages, the four projects failed to gain consensus regarding their legitimacy. This could be blamed on the lack of either a real comprehensive options assessment or an assessment of alternative generating options. It was worst in the case of Victoria because the decision to construct the project was not even based on the assessment of alternative generating options in the framework of a full feasibility study. The decision to construct Victoria was solely based on a preliminary feasibility study that also did not look at alternative generating options. Options assessments were carried out in the case of Nam Ngum1, Magat and Lingjintan, but they were not really comprehensive. Nam Ngum1 looked only at the financial aspects of alternative diesel plants. Magat and Lingjintan went beyond the financial aspects by considering the environmental and social impacts of the power projects and alternatives, but only qualitatively at best.

*Environmental impact is an issue to be considered in the planning of hydropower projects.*

Among the four projects studied, only Lingjintan considered that one benefit from hydropower was the reduction of GHG emissions. In addition, the selection of alternatives indicated that the implementation of the hydropower project could reduce the costs related to the prevention of that type of pollution from thermal alternatives. Magat also compared the environmental impacts of the thermal alternative with the hydropower plant, but only qualitatively.

The increasing level of concern for the state of the local, regional, and global environment underscores the importance of seriously considering environmental issues in hydropower projects. That there was no comprehensive assessment of the environmental impacts of the studied projects raises serious doubts about their acceptability.
The cost of transmission could make the difference when comparing hydropower schemes with a thermal alternative.

Usually, the cost of the transmission system required by a hydropower plant is deemed to be higher than that of a thermal one, as there are few choices when selecting the location of a hydropower scheme. The case of Magat showed that there could be exceptions to that rule. In this case, a transmission line would exist in proximity to the hydropower plant site by the time the project was commissioned. Thus, connecting the plant to the Luzon grid would only require the connection of the plant to the existing transmission line. For that reason, the transmission line to be constructed in the Magat hydropower project was shorter than the line to be constructed for the thermal plant. Indeed, the specific cost of the transmission line was higher for the thermal alternative. The key parameter was the total cost for each alternative, for both power generation and transmission.

The hydropower scheme does not normally provide electrification benefits to the communities living in the immediate area of the dam and reservoir.

The Nam Ngum 1 and Magat hydropower projects were expected to increase industrial development as well as electrification in the Vientiane area and the Cagayan valley, respectively. Although the Vientiane area benefitted from Nam Ngum 1, the Cagayan Valley actually remains agriculture-based and with a low level of electrification. The Victoria and Lingjintan hydropower projects did not consider the benefits to local communities.

The energy benefits from a hydropower project in a cascade of dams may be more than the actual power generated from the project.

In Hunan Province, the benefits expected from power generation at Lingjintan were emphasised by the increased generation that the latter scheme would allow at upstream Wuqiangxi. The planning process for the other projects under study did not consider the possible additional energy benefits due to the interaction of the hydropower plants with the rest of the schemes located in the river basin or on the same river or basin.

4.5.3. Other Water Resource Use Planning

Project planning did not quantify all benefits deriving from the mainly hydropower projects that were considered.

In all four of the case study projects, the main objective was the generation of power and energy to satisfy increasing demand in the region/country and/or export energy to neighbouring countries. Although partly identified during the earlier stages of project planning and design, not all benefits accruing from irrigation, flood control, re-regulation, navigation and downstream low-flow augmentation have been quantified and included in the economic justification of the projects.

However, since water resources planning for most of these projects had been carried out several decades earlier, some additional benefits not “predicted” during these earlier planning stages were identified after the commissioning of the projects.
4.5.4 **Engineering Design**

Engineering design work on large dams has usually been carried out to internationally accepted standards of the day.

The design of large dams requires specialist expertise that is usually found only in international consulting firms or major national institutions with many years of experience in dam design and construction. The involvement of international or bilateral funding agencies also tends to ensure high standards of design through the nomination of expert review panels.

4.5.5 **Social Impact Assessment and Mitigation**

*There has been limited participation of the local population in the planning and decision-making of the case study projects, even in relation to resettlement options.*

Local consultation took place during surveys to assess the assets of project affected persons after the feasibility study and has been largely confined to discussions on compensation and settlement sites.

*In none of the projects studied have social impact assessments identified all affected groups.*

In particular, the impact on any groups downstream of the dam has been neglected, along with those affected by secondary impacts. Pre-feasibility and feasibility studies should pay more attention to such groups, and especially to communities in which fisheries have an important role in coming a livelihood. There is evidence that changes in streamflow and impacts on fish migration through dam closure can seriously affect such communities.

*Failure to undertake timely baseline surveys to establish the social and economic conditions of affected persons can have a major prejudicial effect on plans for the improvement of livelihood.*

In general, such surveys have not been sufficiently comprehensive, either in geographic coverage of in depth. It appears that, in general, they have failed to recognise the complexity of household livelihood strategies, which has then been reflected in failures in compensation and livelihood improvement strategies.

*Inadequate attention has been paid to population dynamics of affected persons.*

Although the definition of project affected persons at damsites and in reservoir areas was generally inclusive in the projects studied, inadequate attention was paid to the dynamics of population growth/family development. At the very least, calculations of project affected persons should be projected to the time of settlement (as for Lijingtan). Failure to do so, combined with possible attempts to cut costs led to the lack of provision for second-generation settlers, especially in the cases of Magat and Victoria. That has had a major effect on livelihood restoration.
There have been gaps in entitlements to compensation.

Eligibility for compensation has generally been inclusive in those cases developed since the 1970s, the only major gap being the ‘second priority’ group at Magat. There have been more unfortunate lacunae in entitlements, such as the failure to compensate for tree crops in Victoria, and a regulation requiring the purchase of land at Magat using compensation payments. This particular decision has contributed significantly to the low returns achieved by settlers from their agricultural operations.

Settlement plans have tended to emphasise infrastructure development at the expense of livelihood development.

Settlement plans were drawn up for the three projects implemented after the mid-1970s. Except for Lingjintan, the plans stressed physical planning of the settlement site, rather than for livelihood development.

Costs of resettlement have substantially exceeded expected levels.

In two cases (Victoria and Lingjintan) out of the three in which a detailed settlement plan was developed, the costs of the final resettlement programme have been several times higher than the level set out in the feasibility studies.

4.5.6. Environmental Impact Assessment and Mitigation

The overall project plan must pay attention to the potential for serious pollution of reservoir water from industrial operations.

Provisions must be made for the control of wastewater discharges from industries in the watershed above the reservoir. These discharges, if left unregulated, could pose serious pollution potentials, including the discharge of heavy metals and other toxic substances.

The overall project plan must also take into account the potential for serious pollution of the reservoir water arising from discharges of domestic sewage wastewater.

These discharges, if uncontrolled, can add large loads to the reservoir water of degradable organics (BOD) and pathogens (as indicated by coliforms), resulting in the degradation of reservoir fisheries and water quality. These sources include communities in the watershed above the reservoir and new communities likely to be established around the reservoir, including fishing villages. The Magat project illustrates the need to control domestic wastewater from communities above the reservoir.

EIA documentation did not sufficiently consider critical biodiversity and wildlife aspects (such as population levels and their livelihood activities) in projecting the impacts on biodiversity.

It was observed that the EIA documentation for Magat only gave cursory consideration to wildlife and biodiversity issues, as can be seen from the rather incomplete animal fauna inventory (e.g., covering raptors and birds). It is very probable that both the dam and the irrigation project negatively affected wildlife resources. Thus, the project may have resulted
in secondary impacts on downstream fisheries and dependent wildlife species, stemming from activities such as the inundation of riparian habitats and road building.

The dearth of biodiversity-related information complicated biodiversity assessment by the EIA studies. That lack of information was the result of inadequate surveys of wildlife resources in the case study areas of Magat, Nam Ngum1 and Victoria. In the case of the Nam Ngum1 project, there was no available wildlife inventory for the pre-impoundment period.

At Magat, the reservoir and irrigation project components accounted for some forestry losses. Moreover, the areas for the transmission line had to be cleared of some trees.

Parenthetically, it may be added that other parallel factors, such as hunting, commercial logging, migrant-driven shifting cultivation, forest fires (whether intentional or accidental) and the subsequent conversion of forest lands to grassland and brushland, may have created additional pressures that have impinged on the prospective ecological sustainability of the biodiversity resources. In the Victoria project, the conflict between wild elephants and the resettler of population in System C appear to underline the fragility of conserving biodiversity resources in watershed areas that are proximate to human habitation.

4.5.7. Economic and Financial Evaluation

Access to financial resources for dam construction was not as much a problem in any of the case studies as it may generally be today.

The main lessons learnt regarding financial planning are that funding appears to be readily available for projects. Nam Ngum1 was funded by grants from foreign countries despite its low rate of return. Victoria was funded separately from the rest of the river basin development plan and ahead of the final plan. Magat and Lingjintan were financed by loans from development banks, and were thus more tightly controlled financially than the others projects.

In the present climate of opinion, such easy finance for dams may no longer available. Dams will need to be justified on their own merits, and the questions asked have become more strident, with some NGOs demanding that no more large dams be allowed at all. Hence, financing dams will likely be much more difficult than in the past.

The case study dams were not planned according to a sectoral model for the power sector

While the process of option assessment in all four case studies was undertaken according to standard practices, the practice followed in selecting the alternative power plant for the hydropower component deserves some comment.

The idea of the comparison is that it should show the hydropower project to be the lower cost option. The present-day practice is to have a sectoral model for the energy or the power sector, in which case the options will be selected based on system-wide considerations. In no case was this done in the planning of the four dams. Instead, the selection of an alternative plant was made on a somewhat ad hoc basis, to show that the project was least-cost for the same level of power output.
Financial analysis was lacking in the case studies, because all were government projects.

No financial analysis was carried out of any of the three dam projects (Nam Ngum1, Victoria, Magat), which were sponsored by the governments who paid the investment costs, to ensure that broad development objectives were met. However, revenues from these dam projects have been received by various operational agencies: EDL (Nam Ngum1), NAPOCOR (Magat), and MDB (Victoria). Moreover, in the case of Magat, NIA has been levying irrigation fees. The cost recovery of these three dam projects has been partial, and unlike any normal private enterprise, profitability was/is not the prime objective of these dam projects.

Economic analysis did not include adequate consideration of social and environmental costs

The social and environmental costs/benefits were not sufficiently taken into account in all the four dam projects during the planning stage. The costs of relocation/resettlement of the project-affected persons were underestimated, resulting in actual payment during the implementation process, exceeding the planned budget. With environmental cost, the loss of riverine fisheries was not accounted for, and benefits from reservoir fisheries were not identified. Since nowadays EIA is, to some extent, required in dam construction projects, this neglect of social and environmental costs/benefits in economic analyses should be redressed.

Economic analysis was used in the four cases studied to establish justification for the projects. Yet they concentrated on the main components of cost-capital and operating costs, and not so much on the social and environmental costs. Social costs were accounted for in the cost of resettlement, which was done very well in the case of Lingjintan and not so well elsewhere. Yet this only goes part of the way and does not fully address the question of loss of welfare after resettlement. In other cases, this aspect was simply ignored after compensation had been paid.

The issue of valuing environmental costs has been incompletely addressed. Not much awareness was shown of the flows of environmental services in the situation without the project. Projects were justified on the basis of benefits to be obtained from them, but the loss of environmental services did not receive adequate attention. Fisheries was a case in point. In all four cases, not much is known about pre-project fisheries. More is known about the project fisheries as in Nam Ngum1, Magat and, to some extent, Lingjintan.

4.5.7.1. Economic Evaluation

(a) Benefits to be valued according to project objectives but not always quantified, including regional and developmental impacts.

While the multipurpose characteristics of dam projects are recognised, in the economic analysis of costs and benefits, not all of these can be quantified. For example, Lingjintan was meant to help navigation in the stretch of river between the dam and Wuquianxi; however, the value of that benefit was not quantified and or included in the cost benefit analysis. Fisheries provide another example of where the reservoir created by the project offers new opportunities for employment and income generation through reservoir fisheries, as shown in the case of Nam Ngum1 and Magat, yet they were not included in the economic analysis at the planning stage.
(b) Economic analysis did not include adequate consideration of social and environmental costs and benefits. However, such costs and benefits may be difficult to quantify.

Economic analysis was used in the four studied cases to establish justification for the projects. Yet, they concentrated on the main cost components (capital costs and cost of operations) and not so much on the social and environmental aspects. Social costs were accounted for in the cost of resettlement, which was done very well in the case of Lingjintan and not so well elsewhere. However, this only goes part of the way and does not fully address the question of loss of welfare after resettlement. In other cases, this aspect was simply ignored after compensation had been paid.

The issue of valuing environmental costs was incompletely addressed. Little awareness was shown of the flows of environmental services in the situation without the project. Projects were justified on the basis of benefits to be obtained from them, but the loss of environmental services did not receive adequate attention. Againsts its are a fishery case in point. In all four cases studies, more is known about the project fisheries while little has been recorded about pre-project fisheries.

(c) The case study dams were not planned according to a sectoral model for the power sector.

While the process of option assessment in all four care study projects was undertaken in accordance with standard practices; the practice followed in reflecting the alternative power plant for the hydropower component deserves some comment.

The idea of the comparison is that it should show the hydropower project to be the lower cost option. Current practice is to have a sectoral model for the energy or power sector, in which case the options will be selected based on system-wide considerations.

In no case was this done in the planning of the dams. Instead, an alternative plant, was relected, on a somewhat ad hoc basis, to show that the project was least-cost for the same level of power output.

(d) Accounting for risks in project costs and benefits

Risk analysis enters into project appraisal by identifying key parameters for project feasibility, where changes in such parameters will have a significant effect on the feasibility of the project. In the four cases studies, divergence between the expected and the actual economic rates of return could have been prevented if the risks in key areas had been adequately accounted for. They included, for example, the risks of underestimating the requirement for resettlement of project affected persons and, in the case of Magat, the risk of sedimentation in the reservoir due to the destruction of forest cover in the upper watershed area of the project. These are factors that can have significant adverse effects on the performance of a dam.
(e) Benefit sharing among stakeholders.

The economic analyses of the case study projects were, in all cases, carried out from the perspective of the national economy. Benefits and costs were added regardless of who might be the beneficiary or the bearer of the cost. Yet, there are many stakeholders, as the discussion on social impacts shows. Where the net benefits to sub-groups of the population are negative, such as in the case of settlers, this implies that the project is being subsidised by the poor. Such cases can lead to opposition to the implementation of the project and, indeed, raise important equity issues.

(f) Use of CBA for participation and gaining acceptance.

In view of the importance of public participation in the process of dam projects, it has to be noted that the case study projects showed only a limited extent of participation. They are all “top-down” projects, treated as “national” projects, with the exception of Lingjintan, which was taken on as a national project by the central government after it had been developed as a provincial government project. In these four cases, the national benefits may have been given priority over the losses suffered by local groups. However, the idea that compensation can be potentially paid may be less acceptable now than the idea that compensation is actually paid, so that no-one is actually worse off with the project than without. In this regard, the cost benefit analysis can be used as an instrument to test the different ways of sharing the benefits and costs of the projects, so that the adverse distributional impacts can be addressed at the planning stage.

4.5.7.2. Financial Analysis

(a) Financial analysis was lacking in the four projects studied because all were government projects.

The distinction between financial and economic analyses was not strictly observed. All four case studies were of government projects, and there was little incentive to achieve cost recovery, since the finance was provided by foreign grants (Nam Ngum1 and Victoria) or loans at concessionary terms (Magat and Lingjintan).

In terms of rates of return, on appraisal Nam Ngum1 showed the lowest rate of return at just 3-4 per cent. This was justified as an infrastructure project. The others gave rates of return on appraisal of more than 10 per cent which were acceptable both in terms of the standard of the day and present standards.

(b) Funding considerations: funds are more difficult to acquire now than previously.

The main lessons learnt regarding financial planning are that funding appears to be readily available for projects. Nam Ngum1 was funded by foreign grants despite its low rate of return. Victoria was funded separately from the rest of the river basin development plan and ahead of the final plan. Magat and Lingjintan were financed by loans from development banks, and were therefore more tightly controlled, financially, than the others three case study projects.

However, this may no longer hold true, and dam projects will have to be justified on their own merit.
A trend towards privatisation of the energy sector and, to some extent, irrigated agriculture will mean that financial criteria will also become more stringent and will be a required component of cost recovery. Hydropower generation performed well enough in the four cases studied. Indeed, Nam Ngum 1 has exceeded expectations as source of revenue and foreign exchange for the country. Magat has gone some way towards cost recovery by collecting water fees, but political intervention has put a brake on achieving a greater level of cost recovery. For Victoria, hydropower generation the main source of revenue and has provided the means of cost recovery in a satisfactory way.

(c) Financial performance differs between sectors

The four case studies have shown that the performance of dams varies from one type of activity to another. Hydropower production has generally been close to the planned target, while irrigation has fallen short of expectations. The financial consequence, as shown in the case of Magat, is immediate. NAPOCOR has done well out of the sale of electricity from the dam while NIA has not been able to collect irrigation fees to the support cost recovery.

4.6 Project Implementation

4.6.1 Construction

Technical problems play a significant role in causing cost overruns and delays in the construction of large dams.

Of the four dam projects covered by the present study, Magat is the only one to have experienced a serious delay lasting several years in the completion of construction. In the Victoria project, final commissioning of the power generating equipment was delayed, but to a much lesser extent than that in the case of Magat. While none of the projects experienced significant cost overruns, it is widely recognised that large dam projects have generally performed badly relative to budgetary targets. The recent WCD review of 23 large dam projects financed by ADB found an average cost overrun of 16 per cent, while the overall WCD review of large dams globally has shown an average cost overrun of 54 per cent.

External factors such as natural calamities, political decisions and social unrest certainly play a role in causing delays. However, the major causes of delays and cost overruns are:

(a) Technical problems that arise during construction, particularly in relation to geotechnical conditions at the dam site and the quality of construction materials;

(b) Poor performance by contractors and equipment suppliers, as in the case of Magat; and

(c) To some extent, poor supervision by the developers, whether government or private contractors.
4.6.2. Rehabilitation of Affected Persons

Delays in land development have delayed livelihood restoration.

Failure to ensure adequate and timely land development, including irrigation, in resettlement areas poses the risk of prejudicing settler livelihoods in the early past of the resettlement process. As a result, settlers face a potential cycle of debt and poverty. This situation is also true where livelihood strategies have centred on tree-crop development. Typical delays in the provision of irrigated and properly levelled land have been between two and four years.

Land-based livelihood improvement strategies have tended to be too narrowly based.

In three of the four dam projects that were studied, settlers have been relocated according to the favoured strategy, mainly in areas benefited by the provision of irrigation water that has partly resulted from dam development. However, agricultural development strategies have been based upon a commodity approach, which, in two of the four projects, have emphasised what is essentially a monoculture.

Agricultural development strategies have concentrated on monoculture of low-value crops.

While market trends may have been difficult to forecast when the cropping patterns were formulated in the 1970s and early 1980s, a strategy based on a greater spread of risk through a more diversified semi-subsistence system might have been more circumspect.

Ethnic minorities have greater difficulty in adjusting to new livelihoods.

Special attention in this regard must be given to ethnic minority communities. Such communities clearly have greater difficulty in adjusting to new opportunities offered by irrigated agriculture (e.g., the Aetto in Sri Lanka) and many lose available development opportunities because of inadequate social networks (e.g., Wigan village at Magat).

Pressures on the agricultural system could be reduced through a well-planned alternative to a land-based development strategy.

Evidence from at least three of the four dams covered by the present study (Nam Ngum1, Magat, Lingjintan) indicates that fisheries and aquaculture in reservoirs and coves can offer a promising alternative livelihood for significant numbers of settlers. While there are dangers that the opportunities in the reservoirs will be appropriated by external interests, these can be overcome by the establishment of a competent reservoir fisheries management system (see section 4.5.1).

Development of non-farm employment has been neglected.

Development of non-farm employment opportunities appears to have been neglected in all four of the case study dams despite inclusion as a major thrust for System C in Sri Lanka. Such opportunities partly depend upon a more diversified agricultural development pattern and the general regional economic situation. This aspect needs to be more carefully assessed and real opportunities for investment identified with, and for, the local population.
Social service provision has not kept pace with the creation of social infrastructure.

While provision of social infrastructure was generally a positive feature of at least three of the case study dams, this component, to be accompanied by better provision for social services themselves. This will require arrangement to be made with the social service agencies (education, health and welfare) for the provision of trained manpower and adequate materials for the new facilities. Settlement agencies may also have to provide the funding necessary for such support in the short-term.

Livelihood development is a long-term strategy.

As a consequence of the above point, agricultural and livelihood development for resettlement areas has to be seen as a long-term strategy. While it may be argued that the problems discussed above are not exclusive to project affected persons, their initial disadvantage demands that they be given special attention by the authorities. In the three older dams studied, authorities attempted to secure follow-up for subsequent development activities on an ad hoc basis. This was partly successful in the cases of Nam Ngum 1 and Victoria, but less so in the case of Magat. Such ad hoc provision is not an adequate basis to ensure development of the livelihoods.

Provision for bridging the income gap, until livelihood development is achieved has been inadequate.

Although development agencies have taken ad hoc measures to offer alternative earning opportunities in the short term (responding to delays in land preparation), only in the case of Lingjintan has there been full acceptance of the need for income subsidies until livelihoods are fully developed. Grants from the National Wealth Tax in the case of Magat have been uneven and inadequate.

4.6.3. Environmental Mitigation

Dam discharges create relevant adverse environmental issues that have to be actively addressed.

Dam discharges are relatively silt-free, hence very erosive (in terms of picking up soil as flow proceeds downstream until a new soil concentration equilibrium is achieved). This factor and the wide variations in discharge volumes can result in significant adverse effects. Such effects would include soil erosion/bank destabilisation and a “disturbed river stretch” for some distance below the dam, with fluctuations in flow volume and water quality that adversely affect aquatic ecology/fisheries and other beneficial uses. This includes those streams with channels for irrigation and water supply.

More attention needs to be given to addressing the impacts of inundation on water quality in reservoirs and in downstream releases

The Mekong River Commission’s extensive studies on the need for clearing reservoir bottom areas of trees and vegetative cover were not conclusive, except for the fact that valuable timber should certainly be removed. The removal of other vegetation leads to reduction in the reservoir fisheries yield. However, if left in place, this vegetation can cause significant water
quality problems, especially in shallow reservoir areas, because of the effects of organic
decomposition in the bottom zone. In deep areas, these problems are overcome because the
overlying water zones are aerobic, and withdrawals can be limited to these zones.

Planning for each particular reservoir should give special attention to this issue. But in case of
doubt, the conservative approach is to remove the bottom vegetation before inundation. Doing
so thus reduces the risk that nutrients derived from the decomposition actions will promote
serious algal blooms in the reservoir and increase the chance of the release from the water of
impaired quality being released. The Nam Ngum1 and Victoria projects, for example,
indicated severe water quality problems (e.g., algal blooms) related to nutrient enrichment
resulting from the failure to remove bottom vegetation before inundation.

4.6.4. Cost Control

Cost overruns occurred in three of the four cases studied, i.e., Lingjintan, Magat and Victoria.
The data on Nam Ngum1 do not allow for an assessment of actual costs.

In the case of Lingjintan, the construction costs were within the planned limit, even allowing
for the addition of another turbine to increase the installed capacity. The cost overrun
occurred in resettlement and livelihood restoration, for which an additional budget was
allocated.

In the case of Magat, the actual overall cost exceeded the planned cost by 2.97 per cent.
According to the Project Completion Report, the main cause of the cost increase resulted from
additional civil works to the designed estimates, particularly the upgrading of existing
irrigation facilities (MRMP 1-a). Cost increases were also experienced in other irrigation
components (MRMP 1-b and MRMP 3), while the costs of constructing the dam and related
structures were actually below the planned budget. The delay in project implementation, from
the planned nine years to 14 years, also added to the overall costs of engineering and
administration.

For Victoria, the cost overrun was 20 per cent. As explained in the Evaluation report in 1985,
the reason was the need to import cement at a higher cost than expected under the project
plan. However, the major cause of the cost increase, which was almost 3.5 times the planned
cost was the underestimation of the population affected by flooding.

In Nam Ngum 1, the cost of resettlement was not formally included in the project cost, and
resettlement was only addressed years later in another project.

The conclusions drawn from the case studies are that:

(a) The engineering estimates are reasonably accurate and can be kept under control;

(b) The cost of imported inputs, which are subject to foreign exchange uncertainties, can
affect project costs.

(c) The cost of resettlement needs to be accurately estimated, starting from the planning
stage, otherwise it can significantly affect the overall project cost; and
(d) The cost of repairing existing structures is also subject to uncertainty and is therefore difficult to estimate accurately.

4.7. Project Operation and Monitoring

4.7.1. Technical Monitoring and Review

Operation of the hydropower plant may be influenced by other criteria than power generation.

Victoria was first intended to meet the irrigation requirement. However, it is difficult to draw any further conclusion at that level, as Sri Lanka’s economy is mainly agriculture-based. In such conditions, it would be hazardous to say that operation should mainly depend on the power requirement. Magat is also dominated by the irrigation component. However, in the case of Nam Ngum 1, due to hard currency income reasons, the project operation has evolved to enable the power benefits to be maximised. In the case of Lingjintan, the navigation requirement was an essential consideration in the operation of the project.

The “lesson learnt” from the four case studies and the review of international literature shows clearly that the era of single-purpose dams, common before about 1970, is essentially over. Henceforth, planning for all new large dams will have to give in-depth attention to multipurpose needs. Severe water shortage situations are beginning to appear all over the world, which will require the standard use of the multipurpose approach in dealing with the problem.

Operation of hydropower schemes may evolve to comply with changes in the economic and political context.

Operation of Nam Ngum 1 was initially aimed at meeting various national demands, but that approach was later changed to maximise the power benefits. For the other projects under study, actual operation corresponds to what had been planned. As noted, the pressures for using all dams to serve multipurpose needs will tend to require adjustments in the original planning objectives.

4.7.2. Environmental Monitoring and Evaluation

A net assessment of environmental and social costs vis-a-vis the environmental and social benefits, through a systematic environmental monitoring and evaluation program me, can lead to a more judicious appraisal of the overall environmental soundness of dam project.

Notwithstanding this discussion of the negative impacts of the four dam projects on the biophysical environment and project affected persons, they must be viewed in the light of the positive environmental and other socio-economic benefits that these projects generate. The benefits include power availability, irrigation water and decreased flooding downstream (because of the flood control function). Another benefit may also arise from the depopulation of the dam and reservoir project area and the resettling of that population in upstream or downstream areas. Thus, beneficial social and economic impacts (e.g., power, irrigation and flood control) arising from a dam project can be enjoyed by the people who have been resettled upstream or downstream. (At the same time, demographic pressure leading to further exploit upland resources is reduced in the dam and reservoir project area).
Nonetheless, such positive impacts will have to be carefully weighed against some adverse fisheries and ecological impacts that a dam project may exert. This includes other negative environmental externalities arising from the ecological implications of the occupation and clearance of upstream catchment areas by displaced communities to compensate for the loss of land in the reservoir area. Such a net assessment of environmental and social costs vis-a-vis the environmental and social benefits can lead to a more judicious appraisal of dam project’s overall environmental soundness (inclusive of both ecological and social soundness). While such an assessment may appear to be a rather Herculean task to undertake in practice (given the current state-of-the-art quantifying techniques that are still methodologically disputed), it may still be beneficial to resort to the use of qualitative assessment techniques for comparative evaluation purposes.

4.7.3. Social and Resettlement Monitoring and Evaluation

Project evaluation is carried out too soon after the completion of construction for progress in livelihood development to be adequately rejected.

Project evaluation usually occurs far too early in what is an ongoing process to be useful for assessment of the results of livelihood development. This usually takes place in the context of project completion reports, which, for the Victoria and Magat schemes, were carried out in 1985 and in 1986, respectively. These reports are not an adequate basis for the evaluation of mitigation of social impacts.

Long-term process of capacity building has been neglected

Only two of the four cases studied had the long-term institutional capacity to deal with settlement and social impact issues. The Hunan Resettlement Bureau has a separate division for projects where construction is complete, while the Mahaweli Authority has long-term authority over the whole area and continues to play an important role in the management of System C.

4.7.4. Financial and Economic Re-evaluation

Given the need to closely monitor the performance of dams to ensure that the expected benefits are realised, an economic and financial evaluation of the project should be carried out on a regular basis. Often, data are kept at the enterprise level and there is considerable difficulty in extracting them for the purpose of comparison between pre-and post-implementation situations. For this reason, data should be maintained in a format that allows for easy comparison between the “before” and “after” project situations.
5. **Recommendations for Large Dam Projects**

This chapter encapsulates the whole raison d’être of the present study. It has been written as an exact reflection of Chapter 4, so that the connection between lessons learnt and recommendations is clearly and easily seen by inter-chapter comparisons. In addition, this chapter deals in somewhat greater detail with project construction and operation. The reason is that some of the major deficiencies of the case studies may be found, and also because it is here that opportunities still exist for mitigation of many negative environmental impacts both ecological and social. This, then, is very similar in philosophy to the WCD strategic priority, “Addressing Existing Dams”.

### 5.1 Main Recommendation

Chapter 4, Section B, concludes that the main lesson learnt is that most deficiencies in project performance result from an inadequate project development and decision-making process. The main recommendation of this Study is therefore as follows:

A comprehensive project development process should be adopted in all dam projects, similar to that depicted in Figure 4-1, which has the following characteristics:

(a) a progressive development of the project commencing with evaluation of the needs and options assessment, and proceeding through feasibility studies, design, and construction, in which technical, economic, social and environmental issues are co-ordinated, with well-defined decision points in the process.

(b) appropriate public and agency participation at all stages of the process.

(d) continuation of the process into the operational phase of the project to permit monitoring of project effectiveness and remedial action as necessary.

### 5.2 Supporting Recommendations

Chapter 4 lists a number of supporting lessons learnt which amplify the main lesson learnt. In a similar manner this section lists supporting recommendations to deal with each of these supporting lessons learnt. For ease of reference, the item numbers of the supporting lessons learnt and the supporting recommendations are the same after the first dot-point.

As in Chapter 4, the principal recommendations are presented as italicized headings for easy reading.
5.3 Policy, and Institutional Framework

5.3.1 Water Resource Policy

There is a need for a clear framework for co-ordinating the planning, implementation and operation of large dam projects.

This framework could be provided by an overall development authority, such as the Mahaweli Authority of Sri Lanka, or through a system of committees in which key institutional stakeholders are all represented. The main concern is that such a body should be given the mandate to consider river basin-wide hydrological and environmental issues, both upstream of the dam (the watershed area) and downstream as far as the project has altered previous riverine hydrology.

Project proposals for the development of large dams must include provision for the support of measures for environmental management, including both key ecological and social issues, including resettlement and restoration of livelihood within the project budget.

The said provisions also need to include support for environmental and socio-economic development activities for an agreed number of years after the project has come into operation. These socio-economic development activities will include provision for support to operations and maintenance of irrigation structures, so as to reduce the burdens on farmers through irrigation charges. This is not to say that water should be provided free, but that some subsidy should be made from project revenues.

5.3.2 Energy Policy

Hydropower projects should be planned within a clear and transparent energy policy framework.

Energy should be seen as a fundamental sector of a nation’s economy. Thus, in the same way as countries have health or education policies, a clear view of the energy priorities of a country is required in order to clarify the development context. The benefit for the power sector is to provide a framework that would set out the objectives regarding the development of both power generation options (including hydropower) as well as power transmission options. Moreover, setting out the energy development strategy of a country in a clear way would reduce the possibility of arbitrary decisions. Thus, a general consensus on energy strategies would be possible before project-specific investments. Finally, precious time could be gained at the options assessment stage, by avoiding renewed discussions on power generation options at the beginning of the planning process.

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5.3.3. **Resettlement Policy**

National guidelines and regulations for addressing the problems of families affected negatively by large water resource development projects should be drawn up by an appropriate national policy-making body.

These guidelines will be sector-specific and should be agreed with all possible implementing agencies within the water resources sector.

*Guidelines should include provisions for consultations with stakeholders.*

The guidelines should set out in detail the provisions for: (a) consultation with project affected persons and other stakeholders; (b) eligibility for, and nature and levels of, compensation to be allowed for loss of livelihood; funding of livelihood subsidies and development activities; grievance procedures. While the detailed provisions should be set out as minimum entitlements (rights), these guidelines should be designed as such, with provision for flexibility in dialogue with project affected persons, and for regular revision, according to inflation and market considerations.

5.3.4. **Environmental Policy**

The main thrust of environmental policy changes, relative to the overall policy, institutional and procedural framework for large dam projects, should address the cause of the failure to systematically incorporate significant environmental considerations into the project planning design, construction and implementation (in terms of a competent environmental planning and management approach that encompasses the use of EIA and the requisite environmental protection measures). Those causes were specifically identified when the study analysed the various dam projects against the backdrop of the suggested project development and decision-making process framework. That framework served as a useful heuristic device or evaluating how the dam projects proceeded in either adequately or inadequately addressing the various technical, policy, economic, social and environmental elements essential to creating optimal conditions for ensuring the overall environmental and social soundness of the dam projects.

Broad environmental policy interventions that could be considered for prospective implementation are:

(a) *Because environmental concerns in large dam projects are cross-cutting in nature and often involve issues that can only be addressed from a systemic perspective, it is imperative to adopt a holistic and integrated strategy at the policy, programme and project levels in dealing with both the proximate and underlying causes of dam-related environmental problems, issues and concerns. Such a holistic and integrated strategy will recognise the multidimensional nature of these environmental issues, which requires the marshalling of interdisciplinary solutions that can facilitate the more effective use of environmental planning and management tools (such as EIA) in the resolution of such issues and concerns.*
The increasingly difficulties that these dam projects face in undertaking environmental planning and management activities that could mitigate negative impacts while enhancing positive impacts have become very clear. Therefore, creative, practical and feasible approaches are needed that utilise both incentives and disincentives to ensure that these planning and management activities are conscientiously carried out. In this respect, proven best practices in various jurisdictions can be adopted for, and adapted to, initial pilot application in future large dam projects.

### 5.3.5. Institutional Management

A sequence of studies should be carried out before the definitive selection of a hydropower project.

Ideally, the planning process of hydropower projects involves reconnaissance studies, a preliminary feasibility study, a full feasibility study and final project design.\(^2\) The reconnaissance studies represent the first step of project-oriented planning. Their purpose is essentially to identify and investigate available hydropower resources. Therefore, although these studies are organised on the same lines as the planning studies that will follow (pre-feasibility, feasibility etc.), they require few details and accuracy.

The pre-feasibility study moves the project one step further along in the planning process. At this stage, planners become more familiar with the project area and concepts, which allows them to formulate some plans for the development of a proposed hydropower project. Although more details are provided than for the reconnaissance studies, (at this stage, a set of projects has been located, identified and given a name) there is still little sense in doing indepth investigations at this stage, as the project features are still likely to change considerably. As reconnaissance and pre-feasibility studies are time - and resource-consuming, they are sometimes combined into one single study. In extreme cases, when sufficient information is available from the beginning of the planning study, the feasibility study can even be carried directly.

This latter stage has a focal importance in the planning process as it brings the comprehensive analysis of the contemplated project directed towards its ultimate authorisation, financing, design and construction. In fact, it is the feasibility study per se that determines and recommends whether the project is sufficiently feasible to proceed. Hence the feasibility study is the key document in the entire planning process. All of the salient “thinking” is summarised in the feasibility study, as to its soundness from all points of view – engineering, institutional, economic, financial, and environmental. That is the season why the EIA must be an integral part of the overall feasibility study (and not a subsequent “add on”). The feasibility study updates and details the results of the preliminary feasibility study and contains the detailed options assessment. Its conclusions must be sufficiently firm to guarantee that no further major alteration or modification that is likely to increase costs significantly or impair the feasibility of the project will be found necessary during the course of final planning and

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\(^2\) Jarle Ravn, 1992, Planning and Implementation of Hydropower Projects, Norwegian Institute of Technology, Division of Hydraulic Engineering, p. 47.
construction. Thus, all the aspects of a project, financial environmental, should be considered in detail during this stage. Consecutively, the feasibility study represents the main base for decision, and cannot be replaced by any other study for the planning process.

Last, the final design study furnishes the detailed technical aspects of the project. As shown in the Magat case study, it can be used to optimise the features proposed in the feasibility study. However, as stated above, possible modifications proposed in the engineering study should not significantly increase the estimated costs provided in the feasibility study, nor should they impair the feasibility of a project.

5.4  Project Planning and Design

5.4.1  Water Resource Planning

Relative to an overall national or regional river basin economy, a dam project may be play a small role. The case of Lingjintan is an example. At the other extreme, Nam Ngum1 was a major investment for the Lao PDR economy, both in terms of investment and revenue generated. Magat and Victoria are both major regional river basin projects, which have become national symbols of development.

The macroeconomic situation of a country provides the important context for dams. Nam Ngum1 is a clear case of using the national resource base to generate foreign exchange. Magat, at the start of operations, provided a higher degree of self-sufficiency in the energy and food sectors of the Philippines economy. Victoria played a major role in the country’s power sector at the time of rising oil prices and reduced the country’s need to import energy. Thus, dams can play an important role in the overall context of macroeconomic development.

The investment required for a dam project is substantial, and mobilisation of such funds is often a major task for the domestic economy. Hence foreign financial sources have played an important role.

The macroeconomic impacts of dam projects are generally positive. Dams expand a country’s productive capacity and relieve important bottlenecks.

As shown by the four case studies, financing dams is only the beginning. The main question is how to make full use of the dams once the investment has been made. In this regard, Nam Ngum1 is a good example of management, with the export of the power output from the dam having provided the main source of foreign exchange for the country for many years. Similarly for Magat and Victoria, the savings made possible by hydropower generation relieved the needs of the Philippines and Sri Lanka for foreign exchange to a significant degree.

The current situation of the international capital market is different from the days when the dams covered by the present study were built. Now the world is awash with money seeking a safe haven with high returns. Dams constitute a long-term project requiring commitment to make them work. Hydropower dams are easier to control than irrigation dams, which depend on complex conditions in the agricultural sector, often with long periods required for returns on investment. To acquire finance, dam project must be tailored to the expectations of the market; however, this objective may be difficult to achieve, given the long-term nature of
most irrigation investments. Alternatives for power generation, such as combined cycle thermal plants, may be a more attractive proposition.

The conclusion is that building a dam cannot be taken for granted as the best answer to the macroeconomic needs for import substitution or exports.

### 5.4.2. Hydropower Planning

*Hydropower projects should be integrated into the least-cost expansion plan to guarantee their cost effectiveness.*

Because resources are scarce, they should be allocated in the best way possible. Therefore, proposed power projects for expanding of power generation capacity should be part of a least-cost solution, or a least-cost expansion plan, which is an optimal combination of power projects. Because of the amount of data to be collected and analysed as well as the complexity of the calculations, least-cost planning uses optimisation and simulation models to generate solutions. In sum, the analysis consists of calculating the present worth of all investments and the system operating cost streams associated with a range of discount rates. The equalising discount rate is then compared with the opportunity cost of capital to identify the least-cost alternative. Different scenarios are developed to simulate likely future situations or the effects of varying conditions. Over time, this process has evolved to consider environmental goals jointly with financial ones for sustainable development purposes.

*The power utility should be directly involved in the planning of large hydropower projects.*

In most Asian countries, a central, vertically integrated power utility is responsible for overall power generation, transmission and distribution. It would have readily available statistics and information on the power market (for example, load forecasts) that are necessary to determine the feasibility of hydropower projects. Moreover, the inclusion of the hydropower project into the least-cost generation expansion plan would only be possible if the power utility participated from the early stages of the project planning process. Last, it would also help to ensure that hydropower projects are consistent with national energy objectives.

The participation of a central power utility in the planning of hydropower projects remains necessary even with the current trends towards deregulation and privatisation of the electricity sector. Even in this case, the tendency to keep large hydropower projects under the jurisdiction of central power utilities remains strong because of the principle of eminent domain and the capital cost involved.

*Within the framework of options assessment, hydropower projects should be compared with alternative power generation options, including the upgrading of existing hydropower plants.*

A complete and detailed options assessment is an important component of the hydropower project planning process as it provides information on the decision-making process itself. Various power generation options, including existing hydropower plants, should be compared during the reconnaissance studies and the pre-feasibility study. However, in order to gain time, the comparison is made in a less detailed way than during the feasibility study. The preliminary option assessments usually focus not only on the general physical features (dam site, dam height, reservoir capacity etc) but also on the general environmental characteristics
related to alternative options, essentially to discard the obviously unfeasible options. Thus, the option assessment to be carried out during the feasibility study is facilitated.

The upgrading of existing dams can, in some cases, be a more cost-effective option than the implementation of new hydropower projects. The actual least-cost plan for the expansion of the power-generating capacity of a country may thus imply the upgrading, re-commissioning or decommissioning of existing hydropower projects. Such issues should therefore be addressed to guarantee that the options retained are the optimal ones. Obviously, the comparison should consider all the perspectives, with particular attention to environmental issues. Assuming that the decision process is clear and transparent, this recommendation is likely to further facilitate public acceptance of a large dam project.

The environmental impacts of hydropower plants and alternative generating options should be considered in both the least-cost expansion plan and the options assessment.

Within the framework of the least-cost expansion plan and options assessment, a more detailed comparison is made. This should definitely show whether the proposed hydropower project is the least-cost option when considering not only financial but also environmental costs. This is important, as provision of the needed Environment Protection Management (EPM) carries significant costs. Thus, the planners have an incentive to learn which project involves the least environmental impacts, and most likely the least EPM costs. Another advantage is the legitimisation of the project in the perception of the public, because the option assessment would show that the project was not selected on arbitrary criteria. This would also reduce the risk of project cancellation or of having to undertake costly major changes to project design following completion of the EIA/feasibility study.

The transmission requirement is an important issue to be addressed during the planning stage of a hydropower project.

Power projects involve the construction of, or connection to, a transmission line, in order to connect the power plant to the national or regional grid. It is necessary to have Indications of the performance of the future transmission line (for example, transmission losses) are required for estimating the future effectiveness of a hydropower project. Moreover, the transmission line costs are part of the total cost of the power scheme. Therefore, omission or underestimation of those costs would lead to underestimating the real total cost of the proposed project. Consequently, it would also create distortions in the options assessment process, and the justification for that hydropower project could be questioned.

From the same perspective, optimisation of the transmission line requires that the authorities responsible for planning the line be informed about the characteristics of the future power plant. Thus, the planning of a power project and the corresponding transmission line cannot be separated.
Generation expansion plans should be accompanied by transmission and distribution plans to ensure distribution of electrification benefits.

One purpose of large hydropower projects should be to increase the level of rural electrification. This can be done only if the transmission and distribution system is planned with this goal in mind. Planning the transmission and distribution requirements simultaneously with the power plant, would facilitate this adaptation, and ensure that the necessary transmission and distribution lines are ready by the time the project is commissioned. Thus, it would be possible to maximise the benefits from the onset of operation.

Consideration of the overall energy benefits of a hydropower scheme should consider any changes in operations of other dams in a cascade on the same river.

In some cases the energy benefits from a hydropower project are not limited only to the power generated at the project itself. When a project is part of a cascade of power plants on the same river, as with Lingjiintan, its construction will increase or reduce the power generation of upstream or downstream schemes. In this case, the benefit criterion is a function of the additional firm power that the new plant is supposed to bring to the system.

From this perspective, during the options assessment, the power plant selected for comparison should take into account the potential benefits due to interactions with the other schemes located on the same river or in the same basin.

5.4.3 Other Water Resource Use Planning

Future dam planning should consider the full range of options offered by a multipurpose development.

To the extent possible, all relevant benefits need to be quantified and included in the economic evaluation of the feasibility study. It is mandatory to perform an economic analysis for comparison of costs and benefits for all development purposes, including power, irrigation, flood control, water supply for municipalities/industries, etc. As noted earlier in this report, the era of single-purpose large dams is over, and all new projects must be multipurpose to varying degrees.

5.4.4 Engineering Design

Hydrological data series in sufficient length and reliability should be supplied in order to avoid erroneous estimates of project inflows leading to inadequate design of the hydropower component and spillway, the latter affecting the dam safety.

The estimate of sediment accumulation in the reservoir and the expected economic lifetime of the project should take into account potential future changes in forest cover and land use, population growth, increases in industrial activities, and unmanaged grazing and shifting cultivation in order to ensure reliable figures.

Before the final dam type can be selected, it should be ensured that all positive and negative impacts are included in the comparison, and that the corresponding field and laboratory data are available in sufficient detail and accuracy.
The entire project layout as well as the final dam site should be optimised in order to ensure that the most advantageous and least-cost arrangement of the project component has been made.

### 5.4.5 Social Impact Assessment and Mitigation

Social impact assessment should be an integral part of the overall project planning process. It involves several steps or aspects as described below.

**Early consultation with those local people likely to be affected by dam construction should be mandatory, but should also reflect local customs.**

Consultation with local people should be initiated at the earliest stages of the project studies and should take place at the lowest level of local government/administration (usually cluster of villages). Without these earlier steps, it may be difficult and “too late” to gain community consensus. “Public consultation” should not be seen in the conventional sense of public meetings and hearings, the formality of which often serves to restrict real discussion, but should reflect local customs. Thus, in some traditional Asian societies, the consultation may be undertaken indirectly through traditional leadership structures, leading to the emergence of a consensual position among the group, which is then reported back to the development agencies.

Such consultations should involve an explanation of why the authorities are considering the project concerned together with an explanation of the process to be followed. They should explain the norms and regulations related to possible resettlement from large-scale water resources development projects. In particular, the consultations should make it plain to the people living in the area/region affected by the project that they are indeed project stakeholders and, hence, are entitled to some sharing of project benefits. Thus, resettled families should not be disadvantaged by the project but should gain from it. All villages in the affected area that are not inundated are entitled to some such benefits, usually to be furnished by the provision of some village amenities, such as rural electrification, water supply and schools, depending upon their priority needs.

Communities should be informed in advance so that they make seek assistance from NGOs and/or people’s organisations in interpreting the procedures.

**Identification and eligibility of project affected persons should be based on comprehensive reconnaissance studies (preliminary social assessment).**

A comprehensive checklist of environmental/social impacts of large dams should be used as an initial checklist/scoping tool for identifying stakeholders and environmental/social impacts at the pre-feasibility stage. Studies of the livelihood systems of communities of various categories of people who may be affected by the various design options available must be made through participatory appraisal surveys. The risks to livelihoods faced by those groups should be made a mandatory part of the study report.
A baseline survey, incorporating a detailed livelihood analysis, should be a constituent element of feasibility study.

A full baseline survey of communities identified in the pre-feasibility as being affected by the project must be carried out as part of the feasibility study. This must cover: (a) a detailed analysis of the livelihood systems of the different groups of project affected persons (already identified in the participatory appraisal studies); and (b) their asset bases. The study must be carried out by institutions experienced in socio-economic survey research, and the results expressed in disaggregated form to demonstrate the different types of impact.

Eligibility for compensation should be inclusive, based upon needs and not the possession of legal title deeds.

In the feasibility study, numerical estimates of each category of project affected persons should be extrapolated from the time of the survey to the likely time of population reallocation.

Basic rights to compensation should be enshrined in national guidelines for large water resource development projects. These norms should be used as the basis for calculating compensation and resettlement costs at the time of pre-feasibility study. However, these should be stated as guidelines or objectives and should be subject to negotiation with project affected persons and their representatives in public meetings that are held in an open and transparent manner following the presentation of the draft results of the feasibility study.

Compensation should comprise several clear and distinct elements:

(a) Compensation for loss of assets (land, home, trees and facilities), either in cash or by replacement;

(b) Compensation to cover the costs of moving and other transitional assistance;

(c) Compensation for loss of livelihood, which should be in the form of alternative plots of land or start-up grants to allow project affected persons to establish alternative livelihoods. Land allocations should be based upon the holding needed to improve on the equivalent income earned before inundation, and not upon the amount of land available. If sufficient land is unavailable, alternative occupations should be offered;

(d) Provisions to compensate for income lost before the situation of the resettled population is stabilised in the new situation;

(e) Provision for training to enable the resettled persons to adjust to new job situations; and

(f) Provision for compensation to those host communities that may be adversely affected by the influx of resettled, persons, e.g., additional and increased use of their schools, hospitals, roads etc.

All costs resulting from compensation, rehabilitation and benefit provision should be borne by the project owner/operator.
Project affected persons should be entitled to subsidies in support of their incomes for a period of at least 10 years after resettlement, which should be provided from the revenues derived from the water resource development project (initially as part of settlement budgets, latterly as a cess on electricity charges). They subsidies should be offered at both community and the individual household level.

*Resettlement plans for displaced project affected persons should deal with the full socio-economic development of the receiving areas.*

These plans should include not only physical plans for resettlement and housing, but also detailed livelihood development plans for different categories of households. These livelihood plans should be developed with the communities concerned and a choice of different alternatives should be provided, according to the availability and skills of different households.

Physical plans in hydroelectric power development projects should ideally include plans for the provision of electricity to project affected persons, whether or not from the transmission system linked to the project. However, such benefits will be part of an overall negotiated package of benefits negotiated with the project affected persons and may be substituted by other elements of the package.

By the same token, whenever possible, project affected persons from projects involving the development of irrigation facilities should be given the opportunity to settle in the irrigation area through land development or purchases of land from existing communities in the command area.

The mutually agreed compensation/entitlements of project affected persons should be set out in formal and legally binding agreements with resettlement authorities or project owners. These agreements/contracts should be monitored by independent organisations or individuals.

### 5.4.6. Environmental Impact Assessment and Mitigation

*The consideration of environmental aspects should cover all stages of project planning, with the degree of depth of the study matching the study scope.*

Focus on the possible environmental and social impacts of a hydropower generation project should begin at the reconnaissance and pre-feasibility stages. The best procedure is to start with an initial environmental evaluation, which determines the many environmental issues that could become serious problems, and to determine which of them are really significant, (i.e., significant environmental issues – SEIs). For identified SEIs, full-scale evaluation is then needed. Failure to carry out such an evaluation will almost certainly result in vigorous opposition to the projects by NGOs. The NGOs are probably correct to regard any large dam project without a competent EIA with “suspicion” in terms of potential for environmental damage. Such projects should not be approved without EIAs.
The EIA study must be an essential part of the project feasibility study.

The key step in ensuring that the environmental soundness of a project is the preparation of an EIA as an integral part of the feasibility study. The feasibility study should emphasize the fact that destruction or alteration of significant environmental or social factors is not an externality to the project’s economic picture, but is very much an “internality” that must be included in the project economic analysis. Therefore, these costs should be fully internalised in order to properly appraise the real value of a large dam project. For that purpose, the impacts should be described in detail in the EMP, including all environmental protection measures needed to address such project impacts. It is also necessary to consider these aspects during the option assessment carried out in the feasibility study, as different projects involve different environmental problems and consequently, different costs. Thus, the detailed environmental studies should be performed as an integral part of the feasibility study, and the findings, conclusions and recommendations must be incorporated into project plans.

Based on the comprehensive study of the EIA process for the four case studies, the following specific practices and guidelines can be recommended for the purpose of policy planning and design with respect to the Environmental Impact Assessment portion of the overall EIA (Figure 5.1).

The TOR for the EIA study of each large dam should cover the significant aspects of watershed conservation and management, and the crafting of a realistic and suitable watershed management plan responsive to project-specific site conditions.

As watershed conservation and management determine the long-term integrity and viability of a dam project, this aspect should not be ignored nor minimised in terms of its potential ensuring that the benefits arising from the dam’s operations are sustained over the long term.

There is a need to conduct baseline environmental (ecological) surveys for upstream and downstream areas as part of the EIA study of each large dam project.

Such surveys will have to cover environmental aspects that are meaningfully linked to the significant environmental issues associated with the dam project, as identified in the scoping phase of the EIA study.

An Environmental Management Office should be established by the project owner/proponent, following approval of the feasibility study/EIA, which should be responsibility for accomplishing all environmental protection measures, including the environmental monitoring programmes.

The TOR for the EIA study of each large dam should cover the significant aspects of watershed conservation and management, and the crafting of a suitable watershed management plan responsive to project-specific site conditions.

Generally, adverse environmental impacts that have a high probability of occurring during project construction and operation will have to be controlled by appropriate environmental protection measures (including mitigation measures).
The various water quality problems that may arise from dam construction and operation must be considered carefully in the project planning stage in order to provide feasible solutions to be applied when designing a dam and its outlet system as well as during the operation and maintenance of these facilities.

The potential adverse impacts on downstream fisheries impacts and potential benefits of reservoir-related fisheries in the planning and operation of the dam project must be carefully evaluated in the project planning process.

In that connection, it may be necessary to conduct more research on reservoir fisheries management practices in order to base them on more ecologically sustainable grounds, and to develop regulations and management techniques for coping with the pressures of overfishing.

Biodiversity conservation efforts undertaken in dam watershed areas must be reconciled with the need of the local communities to obtain their subsistence requirements from the watersheds, while engaging in the sustainable use of the forests and foresting products through ecologically responsible practices (e.g., the use of soil and water conservation in agroforestry livelihood activities).

Enlisting community participation in biodiversity conservation concurrently with the establishment of wildlife refuges and protected areas, such as national parks, can assist in protecting a dam watershed’s forest cover and its associated wildlife communities. Without such community participation in forest resources management, forest degradation and destruction arising from the survival needs of upland migrant settlers and tribal people becomes more probable.

As pointed out in extensive studies carried out on this issue by the Mekong Committee in the 1960s-1970s, it may be highly desirable for a dam/reservoir project itself to take a lead role in protecting upper watershed environmental resources. The Philippines National Power Corporation routinely considers these aspects in their EIA studies for new upland hydropower projects.

The hazard of increased incidence of malaria and of other can be addressed by remedial measures such as anti-malarial spraying campaigns and implementation of other preventive measures.

These measures can range from the periodic use of minimum flushing flows for dam reservoir water, to monitoring and control of known waterborne disease vector organisms, and to the provision of adequate drainage in the dam project area.
**Figure 5-1 : Components of Competent EIA for Dam Projects**

1. **Introduction (TOR, study team, background)**

2. Environmental setting (delineation of the area affected by project, the environmental study area or ESA, and its environmental resources, both ecological and social, especially hydrology and beneficial uses of river systems.

3. Project description (describes project in detail as needed for EIA purposes including discussion of governmental agencies whose approval is needed for obtaining project construction permits).

   3.1. Dam project components.

   3.2. Environmental protection components.

4. EIA and environmental protection measures.

   4.1. Initial environmental evaluation (scoping to delineate significant environmental issues or SEIs).

   4.2. Detailed consideration of each SEI and recommended applicable EPMs

5. Additional EIA components

   5.1. Public participation.

   5.2. Compliance with environmental laws/regulations.

   5.3. Environmental economics.

   5.4. Regional issues (scope of proposed impact in the overall region affected by the project and vice versa) for a hydropower project in the entire river basin section.

   5.5. Global issues.

   5.6. Unavoidable losses of precious ecological resources (if project proceeds).

6. Environmental monitoring (details on all tasks)


   6.2. Operation stage.

7. Environmental management plan

   7.1. Establishment of an Environmental Management Office (EMO) (as integral part of project with sufficient resources to get all EIA/environmental protection measures carried out in subsequent stages of final design, construction, operation, including an environmental monitoring programme.
Figure 5-1: Components of Competent EIA for Dam Projects (Cont’d)

7.2. Provisions for establishing an international panel of environmental experts to meet periodically (every six months) in order to evaluate project environmental performance including performance by the EMO, pertinent government agencies, participating IAAs and others directly concerned.

8. Summary and conclusions

Notes:
(a) Item 4.1.: See Figure 7-6 for detailed listing of SEIs associated with major dam/reservoir projects.
(b) Item 7.1: The EMO, to be establishment by the project owner/proponent following feasibility study//EIA approval, has responsibility for accomplishing all environmental protection measures given in the EIA, including the environmental monitoring programmes. The EMO furnishes administrative support to the Expert Panel. See Note (c).
(c) Item 7.2.: Experience during the 1990s has shown the Expert Panel to be very valuable to ensuring all “project actors” actually make their respective contributions.

5.4.7. Economic and Financial Evaluation

A more complete analysis of the costs and benefits of dams in economic terms is required

In assessing any dam project, evaluating its economic financial impact is a complex process. The non-market impacts of dams are extensive: resettlement of the reservoir area population, the loss of forests and other affected ecosystem services, and the impact of the dam on downstream erosion, fisheries and other aspects of livelihood.

The loss of ecosystem services has to be valued. In that regard, the priority is complete identification of the significant and environmental impacts before the financial and economic analyses can be undertaken.

Financial analysis of each affected group is needed to ensure that they will not be disadvantaged by the project but will actually share fairly in the project benefits.

The standard tools of financial and economic analyses remain widely accepted as the basis for assessing the feasibility of dams. They have the shortcoming of not providing insight into distributional issues. The question is not whether the project as a whole is feasible, but whether there is fair sharing of project benefits among the various stakeholder sectors. Compensation for losses has to be made. This particularly applies to the local populations who are likely to suffer from the adverse consequences of the project: reservoir flooding and fisheries. Resettlement expands the extent of the affected population to the host communities accepting the resettled population.

5.4.7.1. Economic Evaluation

(a) Benefits should be valued according to project objectives and quantified, including macroeconomic, regional and developmental impacts.

In general, the analytical tool of cost-benefit analysis remains applicable to the assessment of the desirability of dam projects. The techniques have developed over the last 30-40 years to become standard procedures for project appraisal that are employed by various donors and...
development funding institutions. Analysis of project costs and benefits now has to take into account and, where possible, quantify the macroeconomic, regional and developmental benefits and costs of projects. The analysis includes the use of shadow prices, regional impact multipliers and other estimates to account for these effects of the project.

(b) Economic analysis should include adequate consideration of social and environmental costs and benefits. Although environmental costs and benefits may be difficult to quantify they can, and should be used with caution.

In assessing a dam project, financial assessment alone is not enough. The non-market impacts of dams are extensive: resettlement of the reservoir area population, the loss of forests and other affected ecosystem services, the impact of the dam on downstream erosion and fisheries, etc.

A more complete analysis of the costs and benefits of dams in economic terms is required. Loss of ecosystem services has to be valued. In that regard, the priority is the complete identification of the social and environmental impacts before the financial and economic analyses can be undertaken.

The treatment of subsidies, whether direct or implicit, in the project appraisal is an important issue. In principle, the economic analysis should take care that subsidies are removed in the analysis. The practice is more difficult, since subsidies may be pervasive. In the case of energy, alternative power generation may involve subsidised fuel, for example, which would leave the dam project disadvantaged. On the other hand, non-market inputs to the dam (e.g., forest land and ecosystem services) may not be fully accounted for, while compensation may be underpaid, livelihood may not be fully restored and so on, which results in the cost of a dam being lower than it should be. Hence, it is necessary to ensure that these distortions of economic values are taken into account and corrected in the economic analysis.

(c) Benefit sharing among stakeholders: analysis of costs and benefits for separate groups of stakeholders. Use of CBA for participation and gaining acceptance.

A benefit analysis needs to be carried out for each affected group to ensure that they will not be disadvantaged by the project, but will actually share in the project benefits.

While the standard tools of financial and economic analyses remain widely accepted as the basis for assessing the feasibility of dams, they have the shortcoming of not giving insight into distributional issues. The question is not whether the project as a whole is feasible, but how to ensure that the stakeholders are not worse off with the dam than without it. Compensation must be made for losses. This particularly applies to the local populations who are likely to suffer from the adverse consequences of the project: reservoir flooding and fisheries. Resettlement expands the number of the affected population to the host communities accepting the resettled population. Hence the need for a financial analysis of each affected group, to ensure that they are not worse off with the project.
(d) Accounting for risks in project costs and benefit should be done through a sensitivity analysis

Where key parameters have been identified with respect to project feasibility, sensitivity analysis should be carried out to assess the extent of the risks to the project from the change in the assumptions.

5.4.7.2. Financial Evaluation

(a) A financial analysis should be done even if it is a government project

The distinctive feature of the four dams covered by the present Study is that although they are all government-sponsored projects, the operators and investors are separate entities. As such, normal financial practices do not apply. Nam Ngum1 was built with a grant, with the revenue going to the EDL and partially to the government. Magat was built with a loan, while the revenue is shared between NAPOCOR and NIA. Cost sharing in the construction was not transparent, and in operation it is less so. Lingjintan was built with one entity as a borrower, while another company is now operating it. The case of Victoria is similar to Lingjintan, in that the dam was built with a grant, and the power company operates and takes the revenue.

Such institutional deviation from the traditional business model means that the usual rules of financial discipline do not apply. Whereas a traditional business would look to cost recovery as the yardstick for measuring performance, and as a way of achieving financial discipline, the institutional arrangement for dams does not permit easy financial control to at least ensure adequate performance. In the absence of such a control system, an appropriate monitoring system is needed to ensure adequate financial and, more importantly, economic performance. To some extent, the trend toward privatisation in infrastructure investment will make this need more apparent and may help to speed up the process of appropriate institutional design for dam projects. Such a system of financial and economic monitoring would also assist in allowing greater participation of stakeholders in the management of dam projects.

(e) Funding considerations: more stringent criteria for project screening and approval

From the four case studies, it can be seen that financing dams is only the beginning. The main question is how to make full use of the dams once the investment has been made. In this regard, Nam Ngum1 is a good example of management, with the export of the power output from the dam providing the main source of foreign exchange for the country for many years. Similarly, for Magat and Victoria, the savings made possible by hydropower generation eased the need of both countries foreign exchange to a significant degree.

The current situation in the international capital market is different from the time when the four dams studied were built. Now the world is awash with money looking for a safe haven with high returns. Dams are a long-term project requiring commitment to make them work. Hydropower generating dams are easier to control than irrigation dams, which depend on prevailing conditions in the agricultural sector. To attract finance, a dam project must be tailored to the expectation of the market but that may be difficult given the long-term nature of the investment. Alternative power generation projects such as combined cycle thermal plants may be a more attractive proposition.
5.5. **Project Implementation**

5.5.1. **Construction**

Considerations concerning dam safety should be incorporated into the planning review.

An independent panel of experts should be periodically involved in the control of all safety-related aspects not only during project construction but also from the beginning of the planning process and during operation of the project. These aspects include:

(a) Adequate foundation conditions and construction materials;
(b) Adequate of field and laboratory investigations;
(c) Main project design and design criteria;
(d) Periodical reviews of flood hydrology and spillway design;
(e) Planning and installation of sufficient safety monitoring devices, including flood warning system;
(f) Inspections; and
(g) Inspection and monitoring of results.

5.5.2. **Rehabilitation of Affected Persons**

*Relocation of project affected persons should be in accordance with the schedule for reservoir filling*

It is important that the relocation of project affected persons should be carefully co-ordinated with the schedule of dam construction and reservoir filling. The relocation will begin with the movement of people from the construction site. Thereafter, however, the livelihood development schedule should be excluded from the project construction schedule, as it has a completely different time-frame. Ideally it should be funded as a separate sub-project.

*The improvement of the livelihoods of project affected persons should be the objective for the preparation of development plans.*

The benefits of the project should be extended to such groups in order to improve on their pre-project situation. During the implementation period, likely shortfalls in income levels from livelihood development activities should be made up through income subsidies that should be included in the budget for resettlement and other social impacts.

*Lessons should be learnt from the general experiences of agricultural development, especially in resource-poor areas, when planning agricultural development options for resettlement.*

Much more attention needs to be given to the typical constraints of agricultural development when designing livelihood improvement strategies. Agricultural development strategies in resettlement areas need to be based upon a farming system research approach that replicates as
much as possible the risk aversion strategies of traditional pre-inundation systems and offers both short-term and long-term earning possibilities. Diversification, based upon local resource potentials rather than monoculture, should be promoted from an early stage. Such diversification should also be based on realistic market opportunities. Support services for the agricultural sector should also be designed to address specific needs.

Livelihood improvement strategies for minority groups in particular should attempt to rebuild traditional systems.

Forest dwellers should be integrated as far as possible into similar environments, with support being given to strategic opportunities for niche intensification. In developing such plans, settlement planners should pay careful attention to recent thinking with regard to development of areas of upland shifting cultivation, which attempts niche intensification within the framework of traditional practices and land-use management systems.

Fisheries and aquacultural development potential, both in the reservoir area and as an element of diversification in the agricultural system, should be exploited.

Development of such opportunities will often require training, specific investment finance and management controls. Candidates for livelihood improvement through this route should be carefully selected and resource management options discussed with, and developed by, the community with the advice of technical specialists. Strict controls on the entry of non-project affected persons groups may be necessary in the first instance.

Non-farm employment opportunities, based on regional economic analysis, should be developed

Development of non-farm employment opportunities is a complex task that depends on careful analysis of the sub-regional economy and the successful development of the agricultural sector. Settlement authorities can probably best facilitate initiatives from project affected persons rather than making direct interventions. This facilitation may take the form of training in skills and management, and the provision of various credit windows (from micro-credit to start-up grants). Incentives may also be offered to firms offering job opportunities to displaced persons.

Resettlement authorities should co-ordinate their efforts with social development agencies, whether they are government or charitable organizations.

These agencies should receive special grants for the provision of the “software” of social infrastructure, including salary incentives for staff willing to work in typically backward areas of resettlement schemes.
5.5.3. **Environmental Mitigation**

An EMO should be established by the project owner/proponent following approval of the feasibility study/EIA.

The EMO should be responsible for accomplishing all environmental protection measures, including environmental monitoring programmes. More importantly, to avert any situation arising between the EMO and the dam project management that leads to collusion and blunt the effectiveness of the environmental protection measures, it is strongly recommended that the EMO be held directly accountable to the local environmental regulatory authority.

*Generally, adverse environmental impacts that have a high probability of occurring during project construction and operation will need to be controlled by appropriate environmental protection measures (including mitigation measures).*

In order to ensure compliance with such measures, viable enforcement mechanisms will have to be adopted and implemented. These may include: (a) the payment of performance bonds; (b) the imposition of penalties for failing to undertake structural as well as vegetative measures for addressing soil erosion; (c) the institutionalisation of needed funds for environmental management purposes in agency line item budgets; and (d) the withholding of contractual payments for failure to properly execute environmental management responsibilities.

*The various water quality problems that may arise from the construction and operation of a dam must be considered carefully during the project planning stage. The objective is to provide feasible solutions for addressing these problems when designing and constructing a dam and its outlet system as well as in operating and maintaining these facilities.*

Anticipated water quality problems (e.g., pollution and thermal/chemical stratification) and its probable causes must be carefully studied and ascertained with the purpose of adopting practical steps for preventing, the occurrence or recurrence of problems during dam construction and operation.

*The potential adverse impacts on downstream fisheries and potential benefits of reservoir-related fisheries in the planning and operation of dam project must be carefully evaluated during the project planning process.*

In that connection, it may be necessary to conduct more research on reservoir fisheries management practices in order to base these on more ecologically sustainable grounds as well as to develop regulations and management techniques for coping with the pressures of overfishing.

The risk of increased incidence of malaria can be addressed through remedial measures such as anti-malarial spraying campaigns and other preventive measures. These measures can range from the periodic use of minimum flushing flows for dam reservoir water, to the monitoring and control of known waterborne disease vector organisms, and the provision of adequate drainage in the dam project area.
Biodiversity conservation efforts undertaken in dam watershed areas must be reconciled with the need of local communities to obtain their subsistence requirements from those areas, while engaging in the sustainable use of forests and forests products through ecologically responsible practices (e.g., the use of soil and water conservation in agroforestry livelihood activities).

The enlisting of community participation in biodiversity conservation concurrently with the establishment of wildlife refuges and protected areas, such as national parks, can assist in protecting a dam watershed’s forest cover and its associated wildlife communities. Without such community participation in forest resources management, forest degradation and destruction arising from the survival needs of upland migrant settlers and tribal people becomes more probable.

As pointed out by extensive studies carried out on this issue by the Mekong Committee in the 1960s-1970s, it may be highly desirable for a dam/reservoir project itself to take a lead role in protecting upper watershed environmental resources. Such protection can even be enhanced further by ensuring the participation of the local communities in such conservation efforts. The Philippines National Power Corporation routinely considers this aspect in its EIA studies on new upland hydro power projects.

**EIAs should involve preparation of an environmental impact mitigation action plan.**

To further augment environmental mitigation and compensation measures for addressing an array of adverse environmental impacts on water quality, biodiversity and fisheries (e.g., fish hatcheries and stocking programmes), the EIA should also prepare an environmental impact mitigation action plan. The plan should be backstopped by a good information base, cooperation between the relevant stakeholders, and regular feedback and monitoring of the effectiveness of the mitigation measures.

**EIAs, study should also prepare an environmental impact enhancement action plan.**

To further strengthen environmental enhancement measures, on EIA should also prepare an environmental impact enhancement action plan to ensure that the positive environmental benefits and gains accruing from the dam project are further improved and enhanced.

**Dam and reservoir projects must also develop an appropriate watershed management plan.**

It is imperative to develop an appropriate watershed management plan for the natural resources and environmental planning and management component of a dam project.

**Clearing the reservoir area of vegetative cover (such as trees) and other organic matter before the area is flooded is an ecologically sound procedure.**

It is important to clear a reservoir area of trees and organic matter before the area is flooded in order to avoid water quality problems arising from organic matter decomposition.
5.5.4. Cost Control

In view of the impact cost overrun on project feasibility, it is important to estimate the cost of a project as accurately as possible at the planning stage. Based on the case studies, the following recommendations are proposed for:

- Engineering costs. The estimation of engineering costs is generally based on new designs and should be based on international prices. Standard practices are available, as illustrated by two examples in Table 5-1.

- Resettlement cost. This cost component can easily be underestimated if the baseline data on population and settlement are inadequate. Special attention should be given during the planning and design stage to the impact on settlement and livelihoods in the project affected areas. Participatory impact assessment processes could be employed in undertaking the planning studies.

- Foreign exchange risks. For imported inputs, allowances should be made for foreign exchange risks.

- Cost of repairs and upgrading of existing structures. Where he project involves restoration or upgrading of existing structures, a thorough survey will be necessary for an accurate estimation of the costs involved. Allowances for contingencies should also be made.

Table 5-1: Comparison of Planned and Actual Costs for Victoria and Magat Projects (at 1985 and 1986 Prices, respectively)

(a) Victoria Dam

<table>
<thead>
<tr>
<th>Component</th>
<th>PFS</th>
<th>Actual</th>
<th>Difference</th>
<th>Overrun (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dam</td>
<td>3,373</td>
<td>3,833</td>
<td>460</td>
<td>13.64</td>
</tr>
<tr>
<td>Tunnel</td>
<td>1,779</td>
<td>1,667</td>
<td>-112</td>
<td>-6.30</td>
</tr>
<tr>
<td>Power station civil works</td>
<td>437</td>
<td>490</td>
<td>53</td>
<td>12.13</td>
</tr>
<tr>
<td>Hydraulic</td>
<td>735</td>
<td>828</td>
<td>93</td>
<td>12.65</td>
</tr>
<tr>
<td>Mechanical and electrical</td>
<td>1,335</td>
<td>1,204</td>
<td>-132</td>
<td>-9.88</td>
</tr>
<tr>
<td>Flooding</td>
<td>385</td>
<td>1,726</td>
<td>1,341</td>
<td>348.31</td>
</tr>
<tr>
<td>Engineering and administration</td>
<td>894</td>
<td>1,061</td>
<td>167</td>
<td>18.68</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>8,939</strong></td>
<td><strong>10,809</strong></td>
<td><strong>1,870</strong></td>
<td><strong>20.92</strong></td>
</tr>
</tbody>
</table>

(US $ millions at 1985 prices)
(b) Magat Dam

(US $ millions at 1986 prices)

<table>
<thead>
<tr>
<th>Component</th>
<th>PFS</th>
<th>Actual</th>
<th>Difference</th>
<th>Overrun (%)</th>
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<tr>
<td>MRMP Stage 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MRMP Stage 1-a</td>
<td>9.50</td>
<td>18.952</td>
<td>9.452</td>
<td>99.49</td>
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<tr>
<td>MRMP Stage 1-b</td>
<td>84.00</td>
<td>92.183</td>
<td>8.183</td>
<td>9.74</td>
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<td>MRMP Stage 2</td>
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<td></td>
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<tr>
<td>Packages 1+2</td>
<td>106.00</td>
<td>396.32</td>
<td>-9.68</td>
<td>-2.38</td>
</tr>
<tr>
<td>MRMP Stage 3</td>
<td>62.00</td>
<td>70.725</td>
<td>8.725</td>
<td>14.07</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>561.50</strong></td>
<td><strong>578.18</strong></td>
<td><strong>16.68</strong></td>
<td><strong>2.97</strong></td>
</tr>
</tbody>
</table>

5.6 Project Operation and Monitoring

5.6.1. Technical Monitoring and Review

Daily releases from dams should consider both energy and irrigation within the existing hydrological parameters.

In the case of multipurpose projects, various organisations are involved in sharing the benefits from project operation. Plant operation is normally guided by the inflows, the reservoir level, the applicable reservoir rule curve and the energy production and irrigation requirements. That could lead to a conflict of interests between the parties involved. The day-to-day releases should be made after considering inflow, and energy and irrigation demands, and their combined effect on the resulting end-of-month elevation of the reservoir level. The volume above the rule curve can be used for additional energy generation. But when the actual elevation falls between the rule curve, water releases for energy generation should be limited to the irrigation demand for the day.

The operation of a hydropower plant should be flexible enough to adapt to potential changes in the economic or political context of a country.

The actual daily and seasonal demands for energy generation and irrigation will already be defined and considered in this rule curve during the first stages of project operation. They should, however, be reconsidered and updated periodically in order to include abnormal effects of energy shortages and/or future demand due to increases of irrigated areas.
When a hydropower project is part of a river basin development plan, its operation should be adapted in order to optimise the energy benefits at the river basin level.

In this case, it is necessary to define water management rules for cascade operation. This is due to the fact that a certain volume of water has much more energetic value upstream than downstream, as the same amount of water will pass different turbines generating more power.

**5.6.2. Environmental Monitoring and Evaluation**

The project monitoring and evaluation component of on EIA should include an environmental impact monitoring and evaluation programme.

Such a programme for both the construction and operational stages will need to be an integral aspect of the overall environmental plan for dam projects.

Baseline environmental (ecological) surveys need to be conducted on upstream and downstream areas as part of the environmental monitoring and evaluation component of both the EIA study of each large dam project as well as the formulation and implementation of an environmental management programme for each project.

Such surveys will have to cover environmental aspects that are meaningfully linked to the significant environmental issues associated with the dam project, as identified in the scoping phase of the EIA.

Such baseline information will be extremely useful later when a dam project is periodically monitored (and routinely compared to such baseline information) on a regular basis in order to ascertain as to whether its natural resource status or environmental quality conditions in the immediate project area (and its wider area of influence such as the downstream areas) are improving or deteriorating.

Lessons, critical observations, useful insights and feedback information generated by the environmental impact monitoring programme should be properly used for adaptive environmental management purposes by the dam project’s planners and decision makers to further improve overall project planning, management and decision making.

For example, a post-audit of the predicted environmental impacts in the EIA study could yield useful lessons on: (a) whether the EIA was adequate; (b) whether the mitigation measures (e.g. for soil erosion control) were implemented and with what degree of success; and (c) what could be done to further improve the process of environmental management through such means as public consultation, scoping and agency review.

Monitoring of migrant influx and access (in conjunction with their livelihood activities) should be incorporated into the environmental impact monitoring and evaluation programme.

There is insufficient evidence of the degree to which hydropower development projects have facilitated access to watershed areas, leading to the exacerbation of forest degradation and loss of wildlife habitats. Thus, it is recommended that monitoring of population movements and their livelihood activities be incorporated into the environmental impact monitoring program.
5.6.3. **Social and Resettlement Monitoring and Evaluation**

*Improvement of livelihood requires ongoing monitoring and periodic evaluations of progress, involving mechanisms for feedback with the objective of positive action.*

As indicated below, the process of resettlement is never completed by the start-up of dam operations. Therefore, the improvement of livelihoods requires regular monitoring of the process. Each agency must develop a monitoring capacity for such projects, either internally or on a contracted basis with an appropriate local institution. Evaluation studies should be also undertaken at regular intervals to ascertain progress towards livelihood development objectives (WCD suggests “longer-term periodic reviews of the performance, benefits and impacts”), and to assess the possibility of phasing out special assistance.

*Funding for livelihood development as well as the provision of project benefits should be financed from the project budget and earnings.*

Settlement authorities must be committed to a long-term (10 years minimum) effort for improving livelihoods, including the maintenance of facilities. This implies that following the project implementation phase, as defined by the completion of construction activities and the official project completion report, it will be necessary to create either a trust fund for the long-term financing of development activities from the project budget, or regular financing by levies on dam income stream (whether from sales of electricity or from irrigation charges).

*Given the need for a long-term perspective on livelihood development, it is imperative that the responsibility for these activities be devolved to local authorities as part of normal operations and maintenance responsibilities at the earliest opportunity. However, this will require attention to capacity-building in planning and management for local governments.*

5.6.4. **Financial and Economic Re-evaluation.**

Given the need to monitor the performance of dams closely in order to ensure that the expected benefits are realised, an economic and financial evaluation of the project should be conducted on a regular basis. Often, data are kept at the enterprise level and there is considerable difficulty in extracting them for the purpose of comparison between pre- and post-implementation situations. For this reason, data should be maintained in a format that allows for easy comparison between the “before” and “after” project situations.
6. Summary of Conclusions

The main lesson learnt from this Study is that:

Significant deficiencies in the performance of a project arise when its development and decision-making process fails to include all the required steps and activities of a comprehensive, progressive project development in which engineering, social and environmental aspects are co-ordinated.

The corresponding main recommendation of this Study is that:

A comprehensive project development process should be adopted in all dam projects, similar to that depicted in Figure 4-1, which has the following characteristics:

(a) a progressive development of the project commencing with evaluation of the needs and options assessment, and proceeding through feasibility studies, design, and construction, in which technical, economic, social and environmental issues are co-ordinated, with well-defined decision points in the process.

(b) appropriate public and agency participation at all stages of the process.

(a) continuation of the process into the operational phase of the project to permit monitoring of project effectiveness and remedial action as necessary.

Such a process offers proponents of a large dam project a framework which is

(i) practicable and usable by project authorities

(ii) accommodating of all interests

The main lesson learnt and main recommendation are amplified by supporting lessons learnt and recommendations. These have been set out in detail in chapters 4 and 5, and have been summarised in tabular form in Table ES 4-1. So that the Executive Summary and the Main Report can be viewed as separate documents, we reproduce here that tabular condensation.
<table>
<thead>
<tr>
<th>Lessons Learnt</th>
<th>Recommended Practices</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Policy and Institutional Framework</strong>&lt;br&gt;1.1 Water Resources Policy&lt;br&gt;(a) Responsibilities of the project operator rarely cover the whole river basin, and there is often an unclear division of responsibilities especially in multipurpose projects.&lt;br&gt;(b) The financial benefits accruing to operating agencies are rarely available for social development and environmental protection measures.</td>
<td><strong>1. Policy and Institutional Framework</strong>&lt;br&gt;1.1 Water Resources Policy&lt;br&gt;(a) There is a need to establish a clear division of responsibilities within each river basin for the co-ordination of planning, implementation and operation of large dam projects.&lt;br&gt;(b) Project proposals for the development of large dams must include provision in the project budget for the costs of measures for environmental management, resettlement and improvement of livelihoods.</td>
</tr>
<tr>
<td><strong>1.2 Energy Policy</strong>&lt;br&gt;It may not be possible for the full capability of hydropower projects to be utilised in the system if they are developed independently of the national energy policy.</td>
<td><strong>1.2 Energy Policy</strong>&lt;br&gt;Hydropower projects should be planned within a clear and transparent energy policy framework.</td>
</tr>
<tr>
<td><strong>1.3 Resettlement Policy</strong>&lt;br&gt;Insufficient attention is given to recognition of the rights of people and their communities living in a project area.</td>
<td><strong>1.3 Resettlement Policy</strong>&lt;br&gt;National policies, guidelines and regulations should be drafted in consultations with stakeholders and particularly for addressing the problems of families affected negatively by large water resource development projects.</td>
</tr>
<tr>
<td><strong>1.4 Environment Policy</strong>&lt;br&gt;(a) Insufficient attention is paid in project design to avoid adverse environmental effects of dam discharges, including water quality issues, reservoir pollution from industrial development and human wastes, biodiversity and wildlife issues, and reservoir and downstream fisheries.</td>
<td><strong>1.4 Environmental Policy</strong>&lt;br&gt;(a) It is imperative to adopt a holistic and an integrated strategy at the policy, programme and project levels for dealing with both the proximate and underlying causes of dam-related environmental problems, issues and concerns.</td>
</tr>
<tr>
<td><strong>1.5 Institutional Management</strong>&lt;br&gt;Generally, the projects could have benefited from better institutional arrangements.</td>
<td><strong>1.5 Institutional Management</strong>&lt;br&gt;(a) Definition of the role of the various governmental agencies involved should be made clear.&lt;br&gt;(b) Clear delineation of the scope of project planning, with meaningful authority, must be given to the responsible project-planning agency.</td>
</tr>
</tbody>
</table>
## 2. Project Planning and Design

### 2.1 Water Resources Planning

(a) Sufficient attention is not paid to co-ordination with land-use planning and the development of appropriate operating policies.

(b) Water resource projects often do not deliver their expected benefits due to inaccurate estimates of river flow and the subsequent invalidation of assumptions regarding upstream water diversion and abstraction during the operational phase.

### 2.2 Hydropower Planning

(a) Failure to carry out a comprehensive options assessment is an obstacle to public acceptance of a hydropower project.

(b) The effectiveness of a hydropower project is not assured unless it has a role in the electric power system in which it operates.

(c) The central power utility is best qualified to determine the duties required of a hydropower project.

## 2. Project Planning and Design

### 2.1 Water Resources Planning

(a) Water resource planning should give particular attention to co-ordination with land use planning and operating policies.

(b) The estimates of river flow and assumptions on upstream water diversions and abstraction should be carefully addressed in the planning stage, reviewed at all stages of project development, and sensitivity analyses must be undertaken to assess the effect of river flow and to determine whether actual diversions and abstraction will be different from what has been assumed.

(c) To increase the reliability of inputs, the estimate of the sediment accumulation in the reservoir should take into account the potential future changes in forest cover and land use, and further engineering research should be undertaken on the means of removing sediment from reservoirs.

(d) Water resources projects should always fairly consider the downstream users particularly in situations where water rights law is poorly developed and enforced.

### 2.2 Hydropower Planning

(a) Prior to conducting feasibility studies, hydropower projects should be compared with alternative power generation options including the environmental impacts associated with each option.

(b) Before adopting a hydropower project, the decision-makers should determine whether it fits into the least-cost expansion plan for the country or region concerned.

(c) The power utility should be directly involved in the planning of a hydropower project.
<table>
<thead>
<tr>
<th>d) Environmental and social impacts are issues that need to be considered in the planning of all dam projects.</th>
</tr>
</thead>
<tbody>
<tr>
<td>e) The cost of transmission could make a significant difference when comparing hydropower schemes with a thermal alternative.</td>
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<tr>
<td>f) A hydropower scheme often does not provide electrification benefits to the communities living in the immediate area of the dam and reservoir.</td>
</tr>
<tr>
<td>g) The energy benefits from a hydropower project in a cascade of dams may be greater than the actual power generated from the project.</td>
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<tr>
<td>2.3 Other Water Resources Use Planning</td>
</tr>
<tr>
<td>Project planning has a tendency to focus on the main purpose of the project (e.g., hydropower) and often does not maximise all the other water resources benefits possible.</td>
</tr>
<tr>
<td>2.4 Engineering Design</td>
</tr>
<tr>
<td>The selection of a design does not always give due consideration to design alternatives which enable more effective mitigation of environmental and other negative impacts.</td>
</tr>
<tr>
<td>d) In undertaking a series of layout studies before making a definitive selection of a particular layout of a hydropower project, the environmental and social impacts of the various layouts should be taken into account.</td>
</tr>
<tr>
<td>e) Generation expansion plans should be accompanied by transmission and distribution plans.</td>
</tr>
<tr>
<td>f) Provision of a medium voltage supply to local communities in the project area should be considered as an essential part of a hydropower scheme.</td>
</tr>
<tr>
<td>g) Consideration of the overall energy benefits of a hydropower scheme should take into account the occurrence of any changes in operations of other dams in a cascade on the same river.</td>
</tr>
<tr>
<td>h) Existing dams should be considered when comparing the possible options for power generation.</td>
</tr>
</tbody>
</table>

2.3 Other Water Resource Use Planning

(a) Future dam planning should consider the full range of options in a multipurpose development project.

2.4 Engineering Design

(a) Before the final dam type is selected, it is important to ensure that all positive and negative impacts are included in the comparison, and that the corresponding field and laboratory data are available in sufficient detail and accuracy.

(b) The final dam site and the entire project layout should be optimised in order to ensure that the most adequate and least-cost arrangement of the project component has been made.
### 2.5 Social Impact Assessment and Mitigation

- **(a)** There is often only limited participation of the local population in the planning and decision-making of the studied projects, even in relation to resettlement options.

- **(b)** Social impact assessments often do not cover the whole possible spectrum of “project affected persons.”

- **(c)** Failure to undertake timely baseline surveys (to establish the social and economic conditions of project affected persons) for consideration in the feasibility stage of project development can jeopardise plans for the restoration of livelihoods.

- **(d)** Inadequate attention is paid to the population dynamics of project affected persons.

- **(e)** There are gaps in rights to compensation.

- **(f)** Settlement plans tend to emphasise infrastructure development at the expense of livelihood development.

- **(g)** Resettlement costs substantially exceed predicted levels.

### 2.6 Environmental Impact Assessment and Mitigation

- **(a)** Project planning often gives inadequate attention to effects on the eco-system, including issues of water quality, impacts on fisheries, etc.

- **(b)** The approval requirement does not always make effective use of the EIA

- **(a)** Appropriate public participation should be an integral part of the overall project planning process, and resettlement planning should be based on the principle that affected persons should be better off after relocation.

- **(b)** Early consultation with the people who are likely to be affected by dam and reservoir construction and operation should be mandatory, and should reflect local customs.

- **(c)** Identification and eligibility of project affected persons should be based on comprehensive reconnaissance studies (based on preliminary social assessment).

- **(d)** A baseline survey, incorporating a detailed livelihood analysis, should be a constituent element of the resettlement plan.

- **(e)** Eligibility for compensation should be inclusive, based on needs and not the possession of legal rights documentation.

- **(f)** Resettlement plans for displaced project affected persons should deal with the full range of socio-economic development of the receiving areas.

- **(g)** Resettlement planning must consider any losses of income and resources (e.g., water supply, downstream fisheries), not just the loss of land or housing.

- **(b)** The EIA study must be an essential part of the project feasibility study.
process (covering ecological, sociological, and economic issues).

(c) Insufficient attention is given to the impacts of inundation on water quality in the reservoir and downstream releases.

(d) The overall project plan often does not take into account the potential for serious pollution of the reservoir water by industrial operations and discharges of sewage and other wastewater.

(e) EIA documentation does not sometimes adequately consider the critical biodiversity and wildlife aspects (such as population levels and their livelihood activities) in projecting the biodiversity impact.

(f) A net assessment of environmental and social costs vis-à-vis the environmental benefits, which can lead to a more judicious appraisal of overall environmental soundness of a dam project is often not carried out.

(c) An Environmental Management Office should be established by the project owner/proponent, following the approval of the feasibility study/EIA, and should have the responsibility for accomplishing all the environmental protection measures, including environmental monitoring programmes.

(d) The EIA study of each large dam should cover the significant aspects of watershed conservation and management, and the crafting of a suitable watershed management plan responsive to project-specific site conditions.

(e) Generally, adverse environmental impacts with a high probability of occurring during project construction and operation will need to be controlled by appropriate environmental protection measures (including mitigation measures).

(f) The various water quality problems that may arise from dam construction and operation must be considered carefully during the project planning stage. This is necessary to ensuring feasible solutions when designing a dam and its outlet system as well as in the operation and maintenance of those facilities.

(g) The more serious adverse impacts on downstream fisheries and potential reservoir-related fisheries benefits in the planning and operation of a dam project must be carefully evaluated in the project planning process.

(h) Biodiversity conservation efforts undertaken in dam watershed areas must be reconciled with the need of the local communities to obtain subsistence requirements from the watersheds, while engaging in the sustainable use of forests and forestry products through ecologically responsible practices. This includes, for example, the use of soil and water
2.7 Economic and Financial Evaluation
(a) Access to financial resources for dam construction was not so much of a problem in any of the four case studies as it may generally prove to be today.

(b) The four case study dams were not planned according to a sectoral model for the power sector.

(c) Financial analyses were lacking in the case studies because they were all government projects.

(d) The economic analysis did not include adequate consideration of social and environmental costs.

(e) Furthermore few cases were found where the distribution of benefits and costs was estimated, and where the project risks were assessed as part of the study.

3. Project Implementation
3.1 Construction
The major issues in construction are delays in completion and over-runs in cost.

3. Project Implementation
3.1 Construction
Adequate site investigation and realistic construction planning are pre-requisites to enabling construction to be completed on time and within budget.

conservation in agroforestry activities.

(i) The hazard of an increased incidence of malaria and other diseases can be addressed through remedial measures such as anti-malarial spraying campaigns and the implementation of other preventive measures.

2.7 Economic and Financial Evaluation
(a) A more complete analysis of the costs and benefits of dams in a sectoral planning model is required. The benefits should be valued according to project objectives and then quantified, including the macroeconomic, regional and developmental impacts.

(b) Even for government projects a full financial analysis based on the marginal cost of untied funds to the public sector should be carried out. A financial analysis is required for each affected group, to ensure that they will not be disadvantaged by the project but will actually share fairly in the project benefits.

(c) Economic analysis should include adequate consideration of social and environmental costs and benefits. However, environmental costs and benefits may be difficult to quantify.

(d) Benefit sharing among stakeholders and analysis of costs and benefits for separate groups of stakeholders is essential. Cost benefit analysis should be used for more participation and gaining public acceptance.

(e) Accounting for risks in project costs and benefits should be carried out as a sensitivity analysis.
### 3.2 Rehabilitation of Affected Persons

| (a) Delays in land development lead to delayed livelihood restoration. |
| (b) Land-based livelihood improvement strategies tend to be too narrowly based. |
| (c) Agricultural development strategies concentrated on monoculture of low-value crops. |
| (d) Ethnic minorities have greater difficulty in adopting, and adjusting to, new livelihoods. |
| (e) Pressures on the agricultural system may be reduced through a well-planned alternative to a land-based development strategy. |
| (f) Development of non-farm employment has been neglected. |
| (g) Social service provision has not kept pace with the creation of social infrastructure. |
| (h) Livelihood development is a long-term strategy and was not adequately addressed. |
| (i) Provisions for bridging the income gap until livelihood development is achieved have been inadequate. |

### 3.2 Rehabilitation of Affected Persons

| (a) The relocation of project affected persons should be carried out in accordance with the schedule for reservoir filling, and in accordance with a separate schedule for the re-establishment of livelihoods. |
| (b) The improvement of livelihoods of project affected persons should be the objective of the preparation of development plans. |
| (c) Lessons should be learnt from the general experiences of agricultural development, especially in resource-poor areas, and applied to the planning of agricultural development options for resettlement. |
| (d) Livelihood improvement strategies for minority groups in particular should attempt to rebuild traditional systems. |
| (e) Fisheries and aquaculture development potential, both in the reservoir areas and as an element of diversification in the agricultural system, should be exploited. |
| (f) Non-farm employment opportunities, based on a regional economic analysis, should be developed. |
| (g) The resettlement authorities should co-ordinate their efforts with social development agencies, whether these are governmental or non-governmental organisations. |
| (h) Rehabilitation should continue on a funded basis well past the construction completion date. |
| (i) Any income gap prior to full development of new agricultural lands or provision of replacement job opportunity should be covered through household income support in cash or in kind; households should not be worse off during the transition period. |
3.3 Environmental Mitigation
(a) Dam discharges create adverse environmental impacts that must be actively addressed.

(b) Greater attention should be given to addressing the impacts of inundation on water quality in reservoirs and downstream releases.

(c) The inundation of forested areas along stream corridors (riparian forests) leading to the reservoir area cause significant ecological impacts, both on biodiversity and wildlife resources.

(d) The dam and reservoir projects have contributed to sub-optimal conditions that have been implicated in declines in downstream fisheries productivity.

(e) The dams have obstructed the passage of migratory fish species, resulting in serious losses of valuable species.

(f) Reservoir fisheries were not adopted as a strategy to offset downstream fisheries facing productivity declines. There is a need to supplant subsistence fishing by the local community with a more ecologically sustainable form of fishing, in terms of a judicious mix of incentives and disincentives (e.g., regulated harvesting and seasonal yield protocols and stricter monitoring and enforcement).

3.3 Environmental Mitigation
(a) The TOR for the EIA study on each large dam should cover the significant aspects of environmental protection and watershed conservation/management as well as the crafting of a realistic and suitable watershed management plan that is responsive to project-specific site conditions.

(b) An Environmental Management Office should be established by the project owner/proponent following the approval of the feasibility study/EIA.

(c) Generally, adverse environmental impacts with a high probability of occurring during project construction and operation need to be controlled through appropriate protection and mitigation measures.

(d) The various water quality problems that may arise from dam construction and operation must be considered carefully during the project planning stage in order to provide feasible solutions when designing and constructing a dam and its outlet system, as well as in operating and maintaining those facilities.

(e) The more serious adverse impacts on downstream fisheries and potential reservoir-related fisheries benefits in the planning and operation of a dam project must be carefully evaluated in the project planning process.

(f) The hazard of an increased incidence of malaria and other diseases can be addressed through remedial measures such as anti-malarial spraying campaigns and the implementation of other preventive measures.
### 3.4 Cost Control

There were significant cost overruns in project construction.

### 4. Project Operation and Monitoring

#### 4.1 Technical Monitoring and Review

(a) The operation of the large dam projects are influenced by criteria other than primary purpose.

(b) The operation of a hydropower plant may evolve to comply with changes in the economic and political context.

(c) Dam safety facilities and a dam safety program are not actively in place in

| (g) Biodiversity conservation efforts undertaken in dam watershed areas must be reconciled with the need of the local communities to obtain subsistence requirements from the watersheds, while engaging in the sustainable use of forests and forestry products through ecologically responsible practices. This includes, for example, the use of soil and water conservation in agroforestry activities. |
| (h) EIA should involve the preparation of an Environmental Impact Mitigation action plan. |
| (i) Dam and reservoir projects must also develop an appropriate watershed management plan, although some dams on large watersheds could not realistically develop or implement such a plan. |
| (j) Clearing the reservoir area of vegetative cover (such as trees) and other organic matter before the area is flooded with water is an ecologically sound procedure that should be carried out prior to the operation of the dam. |

#### 3.4 Cost Control

Cost sharing in the construction and operation of a dam must be transparent. It must be applied with financial discipline and use cost recovery as a yardstick.

#### 4. Project Operation and Monitoring

#### 4.1 Technical Monitoring and Review

(a) Releases from dams should take into account both energy and irrigation requirements as well as flood control and downstream needs.

(b) When a hydropower project is part of a river basin development plan, its operation should be adapted to optimise the energy benefits at the river basin level, and should be flexible enough to adapt to potential changes in the economic or political context of a country.

(c) Instrumentation to monitor the behaviour of a dam should be installed (or retro-
many dams.

<table>
<thead>
<tr>
<th>4.2 Environmental Monitoring and Evaluation</th>
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<tbody>
<tr>
<td>(a) Dam discharges created relevant environmental issues that need to be actively addressed.</td>
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<tr>
<td>(b) The dams have obstructed the passage of migratory fish species, resulting in serious losses of valuable species.</td>
</tr>
<tr>
<td>(c) The dam and reservoir projects have contributed to sub-optimal conditions that have been implicated in declines in downstream fisheries productivity.</td>
</tr>
<tr>
<td>(d) Reservoir fisheries were not adopted as a strategy to (i) offset declines in downstream fisheries productivity and (ii) supplant subsistence fishing for the local community.</td>
</tr>
<tr>
<td>(e) A net assessment of environmental and social costs vis-à-vis the environmental and social benefits through a systematic environmental monitoring and evaluation programme was not carried out in the case study projects.</td>
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</table>

fitted in an existing dam), and a dam surveillance program instituted so that the safety of the dam can be assured throughout its life.

<table>
<thead>
<tr>
<th>4.2 Environmental Monitoring and Evaluation</th>
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<tbody>
<tr>
<td>(a) The project monitoring and evaluation component of an EIA study should include an operation phase environmental impact monitoring and evaluation programme.</td>
</tr>
<tr>
<td>(b) Baseline environmental (ecological) surveys for upstream and downstream areas are needed as part of the environmental monitoring and evaluation component of the EIA study on each large dam project. Such surveys are also needed as part of the formulation and implementation of an environmental management programme for each project.</td>
</tr>
<tr>
<td>(c) Lessons, critical observations, useful insights and feedback of information generated by the environmental impact monitoring programme should be properly utilised for adaptive environmental management purposes by the planners and decision-makers in a dam project, in order to further improve overall project planning, management and decision-making. The institutional and legal instruments to effect changes should be based on monitoring feedback. Excellent monitoring data are of little managerial use if there is no apparatus for translating the data into specific actions.</td>
</tr>
<tr>
<td>(d) The more serious adverse impacts on downstream fisheries, and potential reservoir-related fisheries must be carefully evaluated in the planning process.</td>
</tr>
<tr>
<td>(e) Environmental and social costs must be assessed through a systematic monitoring and evaluation programme.</td>
</tr>
<tr>
<td>4.3 Social and Resettlement Monitoring and Evaluation</td>
</tr>
<tr>
<td>----------------------------------------------------</td>
</tr>
<tr>
<td>(a) Project evaluation carried out too soon after the completion of construction cannot adequately reflect significant social concerns</td>
</tr>
<tr>
<td>(b) The long-term process of capacity building was not evident in the cases studied.</td>
</tr>
<tr>
<td>4.4 Financial and Economic Re-evaluation</td>
</tr>
<tr>
<td>The divergence of expected and actual performance of the dams is often notable, showing that there is a need to closely monitor the post-construction performance of dam projects.</td>
</tr>
<tr>
<td>(a) Attention was not paid to subsidies.</td>
</tr>
<tr>
<td>(b) Financial and economic performance was not measured adequately.</td>
</tr>
<tr>
<td>(c) Comparison of pre-project and post-project is difficult for these cases.</td>
</tr>
<tr>
<td>(d) Financial and economic monitoring of dam performance was inadequate.</td>
</tr>
</tbody>
</table>
APPENDIX

1. Comparison with the Findings of the World Commission on Dams

This study has examined four large dams in Asia in order to determine the key issues in the project planning and implementation process, identify lessons learnt from these key issues and formulate them as recommendations that are acceptable to all stakeholders, for the introduction of best practices in the future. In carrying out these objectives, the study closely paralleled the mandate of the World Commission on Dams (WCD), which was to:

(i) Review the development effectiveness of large dams, and assess alternatives for water resources and energy management; and

(ii) Develop internationally accepted criteria, guidelines and standards, where appropriate, for the planning, design, appraisal, construction, operation, monitoring and decommissioning of dams.

These objectives, the project TOR and the use of WCD methodology have led inexorably to a project perspective that is similar to that of WCD. However, a more flexible perspective might indeed be more practicable. Nevertheless, in sections 1.1 to 1.3 below the key issues identified, the lessons learnt, and the recommendations of this project are compared with those of WCD.

1.1. Key Issues

The present study confirms that the most important key issues revolve round the way various elements are accommodated in the whole project development process. Deficiencies are identified, ranging from involvement of affected persons in the early planning process to monitoring, mitigation and avoidance of unfavourable impacts, as well as to the enhancement of environmental and social considerations. The study thus reinforces the five key points of WCD, and the choice of social and environmental studies for the earlier ADB study. The present study provides a wider sectoral coverage than that in ADB RETA 5793, and also includes dams built with significant objectives other than the generation and supply of hydropower. Nevertheless, the same conclusions emerge, whether the dam was constructed primarily for hydropower generation (Nam Ngum 1 and Victoria), or for hydropower generation with water control (flood prevention and navigation) as a strong secondary purpose (Lingjintan), or for irrigation with hydropower generation as a second objective (Magat).

It is, perhaps, appropriate to reiterate here the first two of the five key points of WCD. These are:

(a) “Dams have made an important and significant contribution to human development, and the benefits derived from them have been considerable,” and

(b) “In too many cases an unacceptable and often unnecessary price has been paid to secure these benefits, especially in ecological and social terms, by people displaced, by communities downstream, by taxpayers, and by the natural environment.”
Returning to the negative key issues identified during the present study, which have led to unacceptable adverse effects, it should be noted that while they align qualitatively with the negative point (b) above, generally the numbers of families displaced and the economic disappointments are quantitatively less than those encountered in the WCD studies.

Of the four dams covered by this study, only Magat was built with irrigation as a primary purpose. The findings parallel those of WCD, in that generally “irrigation services have typically fallen short of physical targets, … and have been less profitable in economic terms than expected”.

Moving on to positive issues, when the economic benefits and costs are placed in the perspective of the geopolitical and geohistorical context of the individual dam, some fine structure in the WCD general observation (a) emerges. A particularly good example is Nam Ngum1, which provided electricity and hard currency income at a time when the Lao PDR had only 10 MW of indigenous capacity and no capability to purchase alternative energy sources. Whether the “bottom line” on the economic least-cost analysis is positive or negative is immaterial to that country, since it received the dam funding as a grant at a time when political considerations minimised economic intercourse with the outside world.

Just as in the WCD study the finding of the present study is that the dams built to deliver hydropower have tended to perform close to target for power generation and have generally met their financial targets. The four dams studied appear not to include the WCD “notable underperformers”. Nevertheless, even though the observations are more of success than failure, lessons have been learnt and, consequently, recommendations formulated.

Turning again to the project development process, the presentation in Chapter 2-9 clearly illustrates that the major departures from today’s standard planning process are first social, then environmental, followed by the economic evaluation of defined purpose and possible alternatives. The social and environmental issues continue through implementation into the operation phase of the project. The planning phase is characterised by inadequate involvement of affected persons in the decision-making processes, inadequate consideration by environmental impacts and inadequate evaluation of alternatives. The implementation phase is characterised by inadequate planning of livelihood restoration and enhancement for resettled families, inadequate attention to the sustainability of compensation measures and inadequate attention to emerging environmental problems. The operational phase is characterised by inadequate sharing of benefits with affected persons, inadequate attention to sustainable livelihood restoration, and inadequate monitoring, mitigation and avoidance of negative social and environmental impacts.

It is natural that key issues such as those mentioned above focus on negative or deficient aspects. This should not divert attention from the fact that the efficient operation of a dam, for power generation and water control, is also a vital issue. The generally successful operation of the four dams within this limited perspective is important. It underlines the fact that large dams can achieve their primary purpose and are capable of providing planned benefits to all stakeholders if negative costs can be avoided.
1.2. Lessons Learnt: Comparison with WCD “Findings and Lessons”

1.2.1. Introduction

The five sectoral sections of the WCD study (Chapters 2 to 6) end with a summary of “Findings and Lessons”. In them, as in the present study, it is difficult to differentiate between “observations” and “lessons learnt”. Nevertheless, the summary sections so titled in the WCD report contain a number of detailed points that are significant “observations” not summarising the lesson (or lessons) learnt from the list of observations. Here the summary lessons of the WCD report are compared with the findings of the present study.

1.2.2. Technical, Financial and Economic Performance

Chapter 2 of the WCD report states:

“...The information on the performance of large dams collected in the WDC Knowledge Base shows that there is considerable scope for improving the selection of projects and the operation of existing large dams and their associated infrastructure. Considering the vast amounts of capital invested in large dams, substantive evaluations of project performance are few in number narrow in scope and poorly integrated across impact categories and scales. The resounding message is that we need better and continued monitoring of technical, financial and economic performance.”

Lessons learnt in the present study, as presented in Chapter 4, completely agree with the above statement.

1.2.3. Eco-system Performance

Chapter 3 of the WCD report states:

“...The ecosystem impacts are more negative than positive and they have led, in many cases, to irreversible loss of species and ecosystems. In the Cross-Check Survey, 67 per cent of the ecosystem impacts recorded were negative’.

To date efforts to mitigate the ecosystem impacts of large dams in the WCD Knowledge Base have met with limited success, owing to the lack of attention given to anticipating and avoiding impacts, the poor quality and uncertainty of predictions, the difficulty of coping with all impacts, and the only partial implementation and success of mitigation measures.”

Lessons learnt in this study again agree with the above statement. The detailed observation from which the lesson is drawn in this Study pays particular attention to water quality.

1.2.4. Social Performance

Chapter 4 of WCD report provides the following summary

“...Past decision-making and planning efforts have often neither adequately assessed nor accounted for the adverse social impacts of large dams. As a result, the construction and operation of large dams has had serious and lasting effects on the lives, livelihoods and health of affected communities, and led to the loss of cultural resources and heritage. At the same
time, a simple accounting for the direct benefits provided by large dams (the provision of irrigation water, electricity, municipal and industrial water supplies, and flood control) often fails to capture the full set of social benefits associated with these services. It also misses a set of ancillary benefits and indirect economic (or multiplier) benefits of dam projects.

In sum, the WCD Knowledge Base demonstrates a generalised lack of commitment or lack of capacity to cope with displacement. The WCD Knowledge Base indicates that the poor, other vulnerable groups and future generations are likely to bear a disproportionate share of the social and environmental costs of large dam projects, without gaining a commensurate share of the economic benefits.

These inequitable outcomes documented in the WCD Knowledge Base invalidate the prevailing ‘balance-sheet’ approach to decision-making. The balancing of gains and losses - as a way of judging the merits of a large dam project – or selecting the best option – is not acceptable where the mismatch between those who gain from the benefits and those who pay the costs is of such a serious, pervasive, and sometimes irreversible nature.”

The same conclusions are drawn by the present study and set forth in Chapter 4.

1.2.5. Options for Water and Energy Resources Development

Chapter 5 of the WCD report states:

“ This chapter has examined the options for fulfilling energy, water and food needs in today’s circumstances, and the barriers and enabling conditions that determine choice or adoption of particular opinions. Many options currently exist, including demand side management, supply efficiency and new supply options. These can all improve or expand water and energy services and meet evolving development needs across all segments of society.

The ability of various options to meet existing and future needs or to replace conventional supplies depends on the specific context, but in general they offer significant potential, individually and collectively.

Numerous market, policy, institutional, intellectual and regulatory barriers hinder the emergence and widespread application of an appropriate mix of options in response to needs in the power and water sectors. The barriers to be overcome include capacity and resource constraints, the dominance of conventional approaches and interests in development planning, a lack of awareness and experience with non-conventional alternatives, inadequate access to capital and a lack of openness in the planning system.

While they are context-specific, hidden subsidies and other incentives to conventional options may limit the use and rate of adoption of even superior alternatives. To better enable the selection and use of the broader range of options will require that options are comprehensively and fairly evaluated by all stakeholders throughout the planning, decision-making and financing process.”

The present study did not examine all options over all four dams in the way that was done by WCD. Nevertheless, the International Consultant Team clearly discerned and reported the inadequacy and narrowness of options assessment in the “Project Development Process”
(Chapter 2). The necessity for a more effective options assessment is very real, and it is clear that this will need to overcome the barriers and restrictions identified by WCD.

1.2.6. Decision-making, Planning and Compliance

The WCD report is at its most critical in Chapter 6. As a result, the summary of “Findings and Lessons” is longer than the other summaries. This includes 29 points of detail applying to both the past and the future. The text summary states:

“The end result of the influence exerted by vested interests, and the conflicts of interest that have arisen, has been that many dams were not built based on an objective assessment and evaluation of the technical, financial and economic criteria applicable at the time, much less the social and ecological criteria that apply in today’s context. That many of such projects have failed to deliver by standards applicable in either context is, therefore, not surprising, but nonetheless cause for concern.

The net effect of these difficulties is that once a proposed dam project has passed preliminary technical and economic feasibility tests and attracted interest from government, external financing agencies or political interests, the momentum behind the project often prevails over further assessment. Moreover, where substantial differences arise between proponents and those potentially affected, efforts to modify plans and decisions often must resort to legal or other action outside the normal planning process.

But poor outcomes and mistrust are not simply a matter of narrow and technically focussed planning and decision-making. They also stem from the failure of dam proponents and financing agencies to fulfil commitments made, observe statutory regulations and abide by internal guidelines.

To sum up, whereas substantial improvements in policies, legal requirements and assessment guidelines have occurred, particularly in the 1990s, it appears that business is still often conducted as usual when it comes to planning and decision-making. Further more, past conflicts remain largely unresolved and past impacts largely unmitigated. The WCD Global Review found that the influence of vested interests, legal and regulatory gaps, disincentives for compliance and lack of monitoring, participation and transparency amongst other things, have combined to create significant barriers to reforms that could otherwise make the planning and decision-making processes more open, responsive and accountable. Recent examples cited in this and earlier chapters are the basis of the Commission’s optimism that these barriers are surmountable and these difficulties are not inevitable.”

The findings of the present study agree with the above, and share the optimism of the concluding sentence that once the lessons have been learnt, the difficulties are not insurmountable. However, an improved approach is required.

In summary, therefore, the major lessons learnt from the present study, with regard to social impacts, parallel those of WCD. They include:

(a) Inadequate attention to affected persons downstream of the project.

(b) Those who were resettled rarely had sustainable livelihoods restored.
The difficulties of livelihood improvement increased with the numbers resettled. The present study extended the project development process to include the operation phase. Thus, many of the lessons learnt in that phase parallel the concepts set out in the WCD report section, “Addressing Existing Dams”. These include, in particular, the following:

(a) The need for longer-term monitoring and review;

(b) The need for continuing mitigation measures (to which should be added positive enhancement of social and environmental conditions); and

(c) The need for programmes to optimise and distribute fairly the benefits of the dams.

It is clear that more sophisticated economic and financial appraisals are required in the planning process, particularly with respect to alternatives and options, as to the inclusion of all expected outputs and impacts. In the present study, no operational financial disparities of the kind found by WCD for Pak Moon in Thailand were encountered. However, there were major omissions or miscalculations related to secondary purposes, such as irrigation, and to the costs of negative impacts, such as resettlement. Environmental costs generally have not been included in the project planning process.

1.3. Comparison with WCD Guidelines

First, it must be emphasised, there is nothing in the present study that suggests a total halt to the consideration and planning of large dams in Asia. The planning process can be made inclusive of all stakeholders, including project-affected persons; it can include objective considerations of alternatives and options; and it can include financial planning encompassing all benefits and costs. Negative social impacts must, and in many cases can, be overcome by ensuring that affected persons are the first, not the last, beneficiaries of the project (as noted by WCD) and that their compensation and livelihood restoration are fully sustainable. That will ensure living standards after the project are an improvement on those before the project; and that, cultural values can be protected. Financial planning and project operation can be brought into coincidence. Many potentially adverse environmental impacts can be minimised, offset or even made positive. There are, of course, eco-system changes that cannot be reversed (at least during the lifetime of the dam). These could represent the only major unavoidable or irremediable costs of the project, and have to be foreseen and balanced against the project benefits on a case by case basis.

This is not to say that all proposed large dam projects should go ahead, but that it is possible to establish an objective planning process, with “go”/“no go” options as well as realistic assessment of how benefits may be maximised and considered against careful minimisation of all costs. The WCD report essentially reached the same conclusion, emphasising the need to minimise “risk” and obtain a “balance” of costs and benefits.

Part 2 of the WCD report, entitled “The Way Forward” is in fact a 126-page exposition of recommendations and advice. Obviously repetition and discussion of the many points therein are beyond the scope of the present study and this appendix. However, WCD does summarise the essential features as 26 “Guidelines for Good Practice”, subdivided under seven “Strategic Priorities.” These are:
Strategic Priority 1: Gaining public acceptance

1. Stakeholder Analysis
2. Negotiated decision-making process
3. Free, prior and informed consent

Strategic Priority 2: Comprehensive options assessment

4. Strategic impact assessment for environmental, social, health and cultural heritage issues
5. Project-Level Impact Assessment for Environmental, social, health and cultural heritage issues
6. Multi-Criteria Analysis
7. Life cycle assessment
8. Greenhouse gas emissions
9. Distributional Analysis of Projects
10. Valuation of social and environmental Impacts
11. Improving economic risk assessment

Strategic Priority 3: addressing existing dams

12. Ensuring operating rules reflect social and environmental concerns
13. Improving reservoir operations

Strategic Priority 4: Sustaining river and livelihoods

14. Baseline ecosystem surveys
15. Environmental flow assessment
16. Maintaining productive fisheries

Strategic Priority 5: Recognizing entitlements and sharing benefits

17. Baseline social conditions
18. Impoverishment risk analysis
19. Implementation of the mitigation, resettlement and development action plan
20. Project benefit-sharing mechanisms
21. Compliance plans
22. Independent Review Panels for Social and environmental matters

Strategic Priority 6: Ensuring compliance

23. Performance bonds
24. Trust funds
25. Integrity pacts

Strategic Priority 7: sharing rivers for peace, development and security

26. Procedures for shared rivers

In contrast, Chapter 5 of the RETA report highlights recommendations, grouped under sectoral sections.

In comparing the two sets of recommendations, the seven strategic priorities can be used as a comparator base.

Then the WCD guidelines 1-3 under Priority 1, “Gaining Public Acceptance” are mirrored in the recommendations in of the present study in Chapter 5 (WCD tends to place more emphasis on the empowerment of affected persons in the decision-making process. In the recommendations of the present study, this is assumed as an evident and necessary aspect of “Participatory Development” (Chapter 5).
The WCD report lists eight guidelines under Priority 2, “Comprehensive Options Assessment.” The present study notes the weakness of options assessment in the four cases studied. Consideration of various power generation options is recommended in Chapter 5. Guidelines concerning various impact assessments (WCD guidelines 4, 5, 10, 11) are reflected in the detailed recommendations in Chapter 5 of this report. The present study does not use multicriteria analysis, although that is in fact what the string of recommendations amount to, nor does it consider greenhouse gas emissions (reservoir compared to thermal power station) or project life cycles. Distributional analysis of projects (WCD guideline 9) is included in the case studies, but does not of itself form a specific recommendation outside those relating to project effectiveness. Finally, the need to improve economic risk assessment (WCD guideline 11) is reiterated in the recommendations of the present study.

Two WCD guidelines under Project 3 “Addressing Existing Dams” are reflected in the attention of the present study to operating rules and compliance set forth in Chapter 5. Improving reservoir operations (WCD guideline 13) did not emerge as an urgent priority in the four cases studied, although there is always room for improvement. In this context, the reader is referred to remarks on dam ownership.

On the need to sustain rivers and livelihood (WCD strategic Priority 4 and guidelines 14-16) the present report echoes the findings and conclusions of WCD. Although the four cases studied did not show such environmental (including fisheries) disasters as are registered in the cases of the WCD work, there is sufficient evidence of negative impacts to formulate strong recommendations concerning the planning stages (Chapter 5) and the operational stage (Chapter 5).

WCD sets out four social recommendations under Priority 5, “Recognising Entitlements and Sharing Benefits.” The recommendations of the present study reinforce the stated need to reduce risk and share benefits in a way that is sustainable. Despite the relative brevity of the present study, it does place rather more obvious stress on “sustainability of compensation and benefit sharing mechanism.

WCD presents five specific guidelines under Priority 6, “Ensuring Compliance.” The post-text comment of Medha Patkar emphasises the concern of the Commissioners with such political issues. In the present study, the International Consultant Team is more guarded. Nevertheless, the team perceived the need to emphasize the role of project donors in post-implementation compliance, a phase when donors are generally conceived as being both impotent and disinterested.

Finally, in Priority 7, “Sharing Rivers for Peace, Development and Security,” the WCD report presents a guideline for “Procedure for Shared Rivers.” In the present study, only Nam Ngum 1 is on a tributary of a river (Mekong) that crosses through several countries, and the tributary itself is wholly in the Lao PDR with little effect on main river flows. Consequently, this is not an aspect on which the present study report can make any observation.

The above discussion began with WCD guidelines, and then considered whether agreement or disagreement emerged in the present study. The WCD study was longer, investigated more dams, and employed a very large number of contributors and correspondents. Nevertheless, it is pertinent to ask whether the present study reveals observations, lessons learnt and
recommendations that WCD may have missed. It is surprising that, given the enormous sociological focus of input to WCD, the RETA study appears to place more emphasis on “sustainability”. This shows most particularly in reference to issues of livelihood restoration and improvement, although it also applies to environmental impacts.

With regard to the 26 WCD guidelines, there are clearly some difficulties in applying all of them uniformly within the present behavioural patterns of developing country governments. Capacity in developing countries is limited. This fact must be taken into account when making recommendations for the overall planning process, and resources have thus to be concentrated on the issues that really matter. For each dam under consideration, the key concerns may well be different. They may be environmental, social, economic or the balance between irrigation and power production. So the recommendations must be characterised by flexibility.

The International, Consultant Team hopes that the Ideal Project Development Flow Chart and associated recommendations given Chapter 5 provide a flexible framework for consideration of future dam projects. In the opinion of the present study, it should be possible to pursue more effective public participation. However, the difficulties involved must not be underestimated.